Department of Energy

Washington, DC 20585

March 4, 1999

Dear Interested Party:

The Final *Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (CLWR EIS) (DOE/EIS-0288) has now been completed and a copy is enclosed.

The CLWR EIS evaluates the environmental impacts associated with producing tritium at one or more of the following five CLWRs operated by the Tennessee Valley Authority (TVA): (1) Watts Bar Nuclear Plant Unit 1 (Spring City, Tennessee); (2) Sequoyah Nuclear Plant Unit 1 (Soddy Daisy, Tennessee); (3) Sequoyah Nuclear Plant Unit 2 (Soddy Daisy, Tennessee); (4) Bellefonte Nuclear Plant Unit 1 (Hollywood, Alabama); and (5) Bellefonte Nuclear Plant Unit 2 (Hollywood, Alabama). Specifically, this EIS analyzes the potential environmental impacts associated with fabricating tritium-producing burnable absorber rods (TPBARs); transporting nonirradiated TPBARs from the fabrication facility to the reactor sites; irradiating TPBARs in the reactors; and transporting irradiated TPBARs from the reactors to the proposed tritium extraction facility at the Savannah River Site (SRS) in South Carolina.

The CLWR EIS follows the December 1995 Record of Decision (60 Federal Register [FR] 63878) for the *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (DOE/EIS-0161). In a December 1995 Record of Decision (ROD), DOE decided to pursue a dual-track approach on the two most promising tritium-supply alternatives: (1) to initiate purchase of an existing commercial reactor (operating or partially complete) or irradiation services with an option to purchase the reactor for conversion to a defense facility; and (2) to design, build, and test critical components of an accelerator system for tritium production (SRS was selected as the location for an accelerator, should one be built). Under the dual-track approach described in the ROD, the Department would, within 3 years, select one of these two technologies as the primary source of tritium. The other technology, if feasible, would serve as a backup. The Department also stated in the ROD that a tritium extraction facility was to be constructed at SRS.

As a result of the PEIS and the ROD, DOE made a determination to prepare three site-specific EISs: the *Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (CLWR EIS) (DOE/EIS-0288), the *Environmental Impact Statement: Accelerator Production of Tritium at the Savannah River Site* (APT EIS) (DOE/EIS-0270), and the *Environmental Impact Statement: Construction and Operation of a Tritium Extraction Facility at the Savannah River Site* (TEF EIS) (DOE/EIS-0271). If you are interested in receiving a copy of the TEF and/or APT EISs, please contact Andrew R. Grainger, NEPA Compliance Officer, Savannah River Operations Office, by calling 1-800-881-7292. Additional copies of the CLWR EIS are also available by contacting Stephen M. Sohinki, Director, Commercial Light Water Reactor Project Office, by calling 1-800-332-0801. The EISs will also be available on the internet at: http://tis.eh.doe.gov/nepa/docs/docs.htm.

Last December 22, U.S. Department of Energy Secretary Bill Richardson announced that commercial light water reactors will be the primary tritium supply technology and that APT will be the "backup" technology. Secretary Richardson designated TVA's Watts Bar and Sequoyah reactors as the preferred facilities for tritium production and this preferred alternative is reflected in the final CLWR EIS. DOE will continue with developmental activities and preliminary design, but will not construct the accelerator.

A consolidated Record of Decision to formalize the December programmatic announcement and complete project-specific decisions for the three final EISs will follow no sooner than 30 days after publication of the Environmental Protection Agency's Notice of Availability in the *Federal Register*. These decisions will include the selection of specific CLWRs to be used for tritium supply, the location of a new tritium extraction capability at SRS, and limited technical and siting decisions consistent with the backup role of the APT.

Thank you for your interest in the Department's Tritium Supply Program.

Sincerely,

Stephen M. Sohinki, Director
Office of Commercial Light Water
Reactor Production

Enclosure:
As stated

COVER SHEET

Responsible Agency: United States Department of Energy

Cooperating Agency: Tennessee Valley Authority

Title: Final Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor

Contact: For additional information on this Final Environmental Impact Statement, write or call:

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1000 Independence Avenue, SW
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Attention: CLWR EIS
Telephone: (202) 586-5484

For copies of the CLWR Final EIS call: 1-800-332-0801

For general information on the DOE National Environmental Policy Act (NEPA) process, write or call:

Carol M. Borgstrom, Director
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Abstract: The U.S. Department of Energy (DOE) is responsible for providing the nation with nuclear weapons and ensuring that these weapons remain safe and reliable. Tritium, a radioactive isotope of hydrogen, is an essential component of every weapon in the current and projected U.S. nuclear weapons stockpile. Unlike other materials utilized in nuclear weapons, tritium decays at a rate of 5.5 percent per year. Accordingly, as long as the nation relies on a nuclear deterrent, the tritium in each nuclear weapon must be replenished periodically. Currently the U.S. nuclear weapons complex does not have the capability to produce the amounts of tritium that will be required to continue supporting the nation's stockpile. The *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (Final Programmatic EIS), DOE/EIS-0161, issued in October 1995, evaluated the alternatives for the siting, construction, and operation of tritium supply and recycling facilities at five DOE sites for four different production technologies. This Programmatic EIS also evaluated the impacts of using a commercial light water reactor (CLWR) without specifying a reactor location. In the Record of Decision for the Final Programmatic EIS (60 FR 63878), issued December 12, 1995, DOE decided to pursue a dual-track approach on the two most promising tritium supply alternatives: (1) to initiate purchase of an existing commercial reactor (operating or partially complete) or reactor irradiation services; and (2) to design, build, and test critical components of an accelerator system for tritium production. At that time, DOE announced that the final decision would be made by the Secretary of Energy at the end of 1998.

On December 22, 1998, Secretary of Energy Bill Richardson announced that the CLWR would be DOE's primary option for tritium production, and the proposed linear accelerator at the Savannah River Site would be the back-up option. The Secretary designated the Tennessee Valley Authority's (TVA) Watts Bar and Sequoyah Nuclear Plants as the Preferred Alternative for CLWR tritium production. The Secretary's announcement that the CLWR would be the primary tritium supply technology reaffirms the 1995 Record of Decision for the Final Programmatic EIS to construct and operate a new tritium extraction capability at the Savannah River Site.

This *Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (CLWR EIS) evaluates the environmental impacts associated with producing tritium at one or more of the following five CLWRs: (1) Watts Bar Nuclear Plant Unit 1 (Spring City, Tennessee); (2) Sequoyah Nuclear Plant Unit 1 (Soddy Daisy, Tennessee); (3) Sequoyah Nuclear Plant Unit 2 (Soddy Daisy, Tennessee); (4) Bellefonte Nuclear Plant Unit 1 (Hollywood, Alabama); and (5) Bellefonte Nuclear Plant Unit 2 (Hollywood, Alabama). Specifically, this EIS analyzes the potential environmental impacts associated with fabricating tritium-producing burnable absorber rods (TPBARs); transporting nonirradiated TPBARs from the fabrication facility to the reactor sites; irradiating TPBARs in the reactors; and transporting irradiated TPBARs from the reactors to the proposed tritium extraction facility at the Savannah River Site in South Carolina.

The public comment period on the CLWR Draft EIS extended from August 28 to October 27, 1998. During the comment period, public hearings were held in North Augusta, South Carolina; Rainsville, Alabama; and Evensville, Tennessee. An additional public meeting was held in Evensville, Tennessee, on December 14, 1998. The CLWR Draft EIS was made available through mailings and requests to DOE's CLWR Office and at DOE's Public Reading Rooms. In preparing the CLWR Final EIS, DOE considered comments received via mail, fax, submission at public hearings, recorded telephone messages, and the Internet. In addition, comments and concerns identified during discussions at the public hearings were recorded by a court reporter and were transcribed for consideration by DOE.

The CLWR Final EIS contains revisions and new information in response to the comments on the CLWR Draft EIS and technical details disclosed since the Draft EIS was issued. These revisions and new information are indicated by a double underline for minor word changes or by a sidebar in the margin for sentence or larger changes. Volume 2 (Comment Response Document) of the CLWR Final EIS contains the comments received during the public review of the CLWR Draft EIS and DOE's responses to these comments.

No sooner than 30 days after the notice of filing this EIS with the U.S. Environmental Protection Agency, DOE expects to issue a Record of Decision.

PREFACE

The *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (Final Programmatic EIS) (DOE/EIS-0161), which was completed in October 1995, assessed the potential environmental impacts of technology and siting alternatives for the production of tritium for national security purposes. On December 5, 1995, DOE issued a Record of Decision for the Final Programmatic EIS that selected the two most promising alternative technologies for tritium production and established a dual-track strategy that would, within 3 years, select one of those technologies to become the primary tritium supply technology. The other technology, if feasible, would be developed as a backup tritium source. Under the dual-track strategy, DOE would: (1) initiate the purchase of an existing commercial reactor (operating or partially complete) or irradiation services with an option to purchase the reactor for conversion to a defense facility; and (2) design, build, and test critical components of an accelerator system for tritium production. Under the Final Programmatic EIS Record of Decision, any new facilities that might be required, i.e., an accelerator and/or a tritium extraction facility to support the commercial reactor alternative, would be constructed at DOE's Savannah River Site in South Carolina.

The Final Programmatic EIS described a two-phase strategy for compliance with the National Environmental Policy Act (NEPA). The first phase included completion of the Final Programmatic EIS and subsequent Record of Decision. The second phase included the preparation of site-specific NEPA documents tiered from the Final Programmatic EIS. These EISs address the environmental impacts of specific project proposals. As a result of the Final Programmatic EIS and the Record of Decision, DOE determined to prepare three site-specific EISs: the *Environmental Impact Statement, Accelerator Production of Tritium at the Savannah River Site* (APT) (DOE/EIS-0270), the *Environmental Impact Statement for the Production of Tritium in a Comercial Light Water Reactor* (CLWR) (DOE/EIS-0288), and the *Environment Impact Statement, Construction and Operation of a Tritium Extraction Facility at Savannah River Site* (TEF) (DOE/EIS-0271). Each of these EISs presents an analysis of alternatives which do not affect the alternatives in the other EISs, with one exception. This exception is one alternative in the TEF EIS which would require the use of space in the APT. For this alternative to be viable, the APT would have to be selected as the primary source of tritium.

On December 22, 1998, Secretary of Energy Bill Richardson announced that commercial light water reactors (CLWR) will be the primary tritium supply technology. The Secretary designated the Watts Bar Unit 1 reactor near Spring City, Tennessee, and the Sequoyah Units 1 and 2 reactors near Soddy-Daisy, Tennessee, as the preferred commercial light water reactors for tritium production. These reactors are operated by the Tennessee Valley Authority (TVA), an independent government agency. The Secretary designated the APT as the "backup" technology for tritium supply. As a backup, DOE will continue with developmental activities and preliminary design, but will not construct the accelerator. Finally, selection of the CLWR reaffirms the December 1995 Final Programmatic EIS Record of Decision to construct and operate a new tritium extraction capability at the Savannah River Site.

DOE has completed the final EISs for the APT, CLWR, and TEF. No sooner than 30 days after publication in the *Federal Register* of the Environmental Protection Agency's Notice of Availability of the final EISs for APT, CLWR, and TEF, DOE intends to issue a consolidated Record of Decision to: (1) formalize the programmatic announcement made on December 22, 1998; and (2) announce project-specific decisions for the three EISs. These decisions will include, for the selected CLWR technology, the selection of specific CLWRs to be used for tritium supply and the location of a new tritium extraction capability at the Savannah River Site. For the backup APT technology, technical and siting decisions consistent with its backup role will be made.

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ACRONYMS AND ABBREVIATIONS

APT	Accelerator Production of Tritium
BEIR	Biological Effects of Ionizing Radiation
Bellefonte 1	Bellefonte Nuclear Plant Unit 1
Bellefonte 2	Bellefonte Nuclear Plant Unit 2
CFR	Code of Federal Regulations
CLWR	Commercial light water reactor
DOE	U.S. Department of Energy
EIS	Environmental impact statement
EPA	U.S. Environmental Protection Agency
FR	Federal Register
HEPA	High-efficiency particulate air
IAEA	International Atomic Energy Agency
ISFSI	Independent spent fuel storage installation
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
P.L.	Public Law
Sequoyah 1	Sequoyah Nuclear Plant Unit 1
Sequoyah 2	Sequoyah Nuclear Plant Unit 2
START	Strategic Arms Reduction Treaty
TPBAR	Tritium-producing burnable absorber rod
TVA	Tennessee Valley Authority
U.S.C.	United States Code
Watts Bar 1	Watts Bar Nuclear Plant Unit 1
Watts Bar 2	Watts Bar Nuclear Plant Unit 2

SUMMARY

S.1 INTRODUCTION AND BACKGROUND

S.1.1 General

The U.S. Department of Energy (DOE) is responsible for providing the nation with nuclear weapons and ensuring those weapons remain safe and reliable. Tritium, a radioactive isotope of hydrogen, is an essential component of every weapon in the current and projected U.S. nuclear weapons stockpile. Unlike other nuclear materials used in nuclear weapons, tritium decays at a rate of 5.5 percent per year. Accordingly, as long as the nation relies on a nuclear deterrent, the tritium in each nuclear weapon must be replenished periodically.

> **What is Tritium?**
>
> *Tritium is a radioactive isotope of hydrogen that occurs naturally in the environment in small quantities. However, it must be manufactured to obtain useful quantities. Tritium is not a fissile material and cannot be used by itself to construct a nuclear weapon. It is, however, an essential component of every warhead in the current and projected nuclear weapons stockpile. These warheads depend on tritium to perform as designed. Tritium decays at about 5.5 percent per year; therefore, it requires periodic replacement.*

At present, the U.S. nuclear weapons complex does not have the capability to produce the amounts of tritium that will be required to support the nation's current and future stockpile. Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 *et seq*.) and the DOE regulations implementing NEPA (10 CFR 1021), this *Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (CLWR EIS) analyzes the potential consequences to the environment associated with the production of tritium using one or more Commercial Light Water Reactors (CLWRs).

Concurrent with the preparation of this EIS, DOE evaluated the feasibility of various CLWR alternatives through its standard procurement process (see Section S.1.4). This EIS evaluates the environmental impacts associated with tritium production for all Tennessee Valley Authority (TVA) reactor plants that were offered by TVA during the procurement process. DOE is considering only the purchase of irradiation services, not the purchase of a reactor. Purchase of a reactor is no longer considered because, based on the proposals offered during the procurement process, no reactors were offered for sale.

S.1.2 Proposed Action and Scope

DOE proposes to use one or more CLWRs to provide tritium in sufficient quantities to support the nation's nuclear weapons stockpile requirements for at least the next 40 years. The proposed action includes: the manufacture of tritium-producing burnable absorber rods (TPBARs) at a commercial facility; irradiation of the TPBARs at one or more of five operating or partially constructed TVA nuclear reactors; the possible completion of TVA's nuclear reactors; transportation of nonirradiated and irradiated materials; and the management of spent nuclear fuel and low-level radioactive waste.

As depicted in **Figure S–1**, this EIS analyzes the potential environmental impacts associated with: (1) fabricating TPBARs; (2) transporting nonirradiated TPBARs from the fabrication facility to the reactor sites; (3) irradiating TPBARs in the reactors; and, (4) transporting irradiated TPBARs from the reactors to the proposed Tritium Extraction Facility at the Savannah River Site in South Carolina. This EIS further analyzes

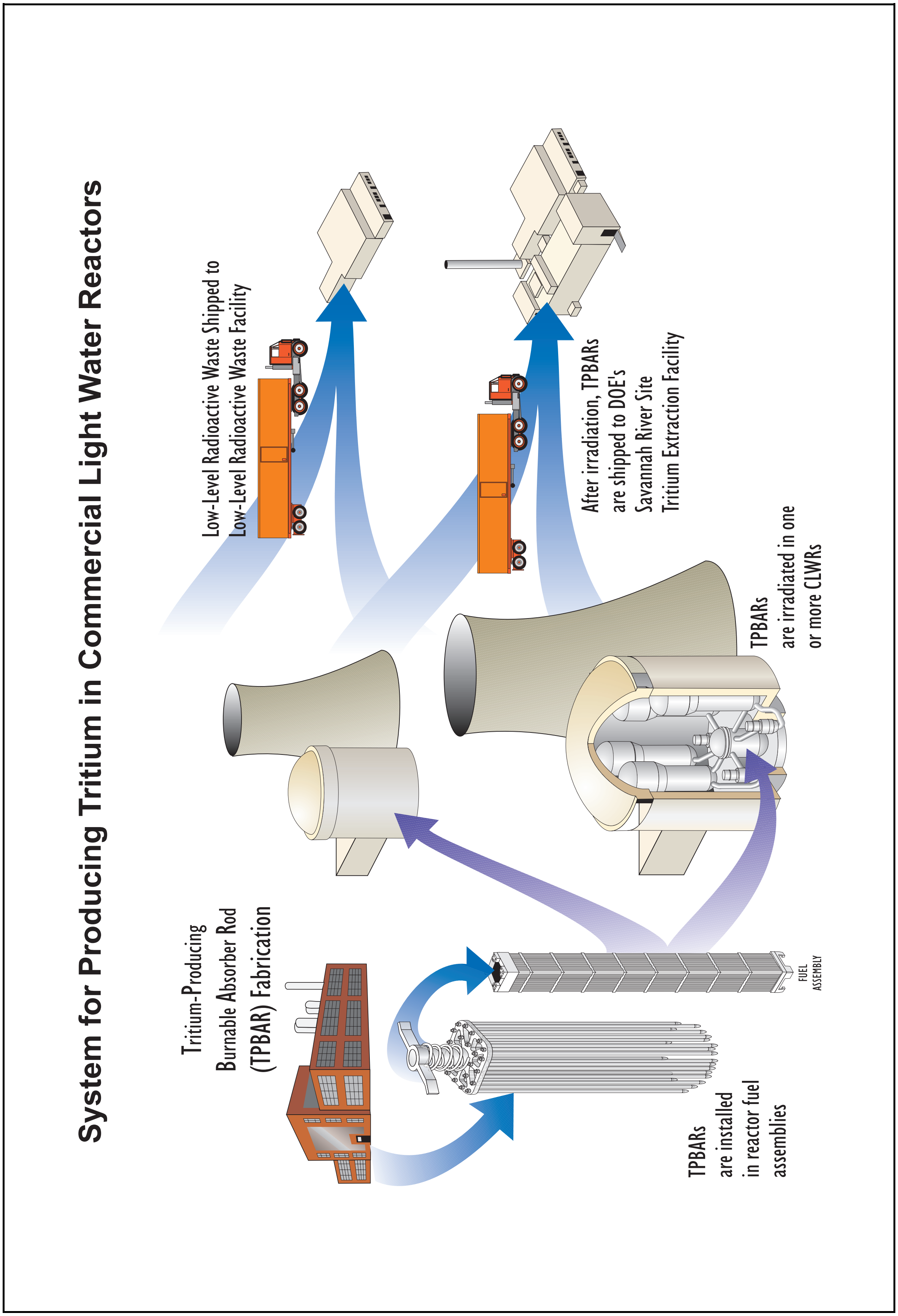


Figure S–1 Schematic of Process for Producing Tritium in CLWRs

the potential environmental impacts associated with both the management of spent nuclear fuel and the transportation and management of low-level radioactive waste generated from CLWR tritium production.

In addition, this EIS evaluates the environmental impacts of the No Action Alternative. Under the No Action Alternative, the stockpile requirements for tritium would have to be met by the construction and operation of an accelerator at DOE's Savannah River Site in South Carolina (see Section S.1.6.2.1). For the purpose of this EIS a No Action Alternative (i.e., no tritium production at that CLWR) has been evaluated for each candidate reactor facility.

S.1.3 Development of the CLWR EIS

> ***What is a CLWR?***
>
> *A CLWR is a nuclear reactor designed and constructed to produce electric power for commercial use. Tritium can be produced during normal operation of a CLWR. The process uses TPBARs which, like the burnable absorber rods that they replace, absorb excess neutrons and help control the power in a reactor. Pressurized water reactors are well suited for the production of tritium because the TPBARs can be inserted into the nonfuel positions of the fuel assemblies. Tritium is generated within the TPBARs as they are irradiated during normal reactor operation.*

The CLWR EIS is a tiered document that follows the December 1995 Record of Decision (60 Federal Register 63878) for the *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (Final Programmatic EIS). In that Programmatic EIS, DOE considered a range of reasonable alternatives for obtaining the required quantities of tritium. In the December 1995 Record of Decision, DOE decided to pursue a dual-track approach on the two most promising tritium-supply alternatives: (1) to initiate purchase of an existing commercial reactor (operating or partially complete) or irradiation services with an option to purchase the reactor for conversion to a defense facility; and (2) to design, build, and test critical components of an accelerator system for tritium production (the Savannah River Site was selected as the location for an accelerator, should one be built).

DOE committed to selection of one of these approaches by the end of 1998 to serve as the primary source of tritium. The other alternative, if feasible, would continue to be developed as a backup tritium source. Production of tritium in an accelerator is analyzed in the *Draft Environmental Impact Statement, Accelerator Production of Tritium at the Savannah River Site* (APT Draft EIS), DOE/EIS-0270 (see Section S.1.6.2.1).

On December 22, 1998, U.S. Department of Energy Secretary Bill Richardson announced that tritium production in one or more CLWRs would be the primary tritium supply technology and that the accelerator would be developed, but not constructed, as a backup to CLWR tritium production. Secretary Richardson further stated that the Watts Bar and Sequoyah reactors have been designated as the Preferred Alternative for CLWR tritium production. The Secretary's announcement that the CLWR would be the primary tritium supply technology reaffirms the 1995 Record of Decision for the Final Programmatic EIS to construct and operate a new tritium extraction capability at the Savannah River Site.

S.1.4 The CLWR Procurement Process

The production of tritium in a CLWR would require a contract/interagency agreement between DOE and the owner/operator of the CLWR. Accordingly, on June 3, 1997, DOE issued in final form a Request for Proposals from owners/operators for irradiation services or sale of a CLWR. In September 1997, DOE received proposals for producing tritium using operating or partially completed reactors. The proposals for the Watts Bar and Bellefonte Nuclear Plants received from TVA were the only proposals determined to be responsive to the requirements of the procurement request. Under Federal Procurement Law, a proposal is "responsive" if it meets the criteria set forth in the agency's Request for Proposals. In addition to the responsive bids discussed in this EIS, DOE received one nonresponsive bid. That bid did not offer to produce tritium. TVA initially offered Watts Bar Nuclear Plant Unit 1 (Watts Bar 1) and Bellefonte Nuclear Plant Unit 1 (Bellefonte 1). Since Bellefonte 1 was a partially completed unit, in the event that it could not be completed and licensed in time to support DOE's requirements for tritium production, TVA, through the procurement process, offered to make Sequoyah Nuclear Plant Units 1 and 2 (Sequoyah 1 and 2) available to meet the need for tritium. In addition, Bellefonte Nuclear Plant Unit 2 (Bellefonte 2) was considered a reasonable alternative. These reactors, the location of which are shown in **Figure S–2**, are owned by the U.S. Government and operated by TVA. They are as follows:

- Watts Bar Nuclear Plant Unit 1 (Watts Bar 1), Spring City, Tennessee (operating)
- Sequoyah Nuclear Plant Unit 1 (Sequoyah 1), Soddy-Daisy, Tennessee (operating)
- Sequoyah Nuclear Plant Unit 2 (Sequoyah 2), Soddy-Daisy, Tennessee (operating)
- Bellefonte Nuclear Plant Unit 1 (Bellefonte 1), Hollywood, Alabama (partially complete)
- Bellefonte Nuclear Plant Unit 2 (Bellefonte 2), Hollywood, Alabama (partially complete)

Because both TVA and DOE are Federal agencies, an interagency agreement between them could be reached via the Economy Act (31 U.S.C. 1535). The Economy Act is a Federal law that allows two government agencies to enter into an interagency agreement similar to the contractual agreement that a Federal agency would enter with a nonfederal party through the competitive procurement process. The Federal procurement process for the CLWR program explicitly allows for an interagency agreement via the Economy Act.

Subsequent to the initial TVA proposals, in May 1998 TVA allowed its initial procurement proposal for selling irradiation services at the Sequoyah and Watts Bar reactors to expire. However, because the TVA proposals are also subject to the Economy Act, this action did not affect the TVA reactor alternatives. Thus, the CLWR Draft EIS assessed all five of the TVA reactors as reasonable alternatives for tritium production. In November 1998, Energy Secretary Richardson asked TVA to submit a revised proposal for irradiation services at the Watts Bar and Sequoyah reactors, as well as final proposals for completion of Bellefonte, so that he would have a comprehensive set of options on which to base the technology decision. In December 1998, TVA submitted revised proposals for both the Watts Bar and Sequoyah reactors, as well as Bellefonte. Consequently, all of the alternatives that were evaluated in the CLWR Draft EIS remain as reasonable alternatives in the CLWR Final EIS.

DOE may enter into an interagency agreement with TVA, contingent on completion of the NEPA process, for production of tritium required to support the nuclear weapons stockpile. Only those actions that are determined not to have an adverse effect and not to limit the choice of reasonable alternatives would be permitted prior to the completion of the NEPA process. However, before completion of the CLWR EIS and its associated Record of Decision, DOE and TVA will have taken and will continue to take appropriate actions (e.g., studies, analyses) related to the potential submission of licensing documents to the U.S. Nuclear Regulatory Commission (NRC). The NRC must approve the use of TPBARs in licensed reactors.

S.1.5 Background

S.1.5.1 Defense Programs Mission

Since the inception of the nuclear weapons program in the 1940s, DOE and its predecessor agencies have been responsible for designing, manufacturing, maintaining, and retiring the nuclear weapons in the nation's stockpile. In response to the end of the Cold War and changes in the world political regime, the emphasis of the United States' nuclear weapons program has shifted dramatically over the past few years from producing weapons to dismantling weapons. Accordingly, the nuclear weapons stockpile is being greatly reduced; the United States is no longer producing new-design nuclear weapons; and DOE has closed or consolidated many former weapons production facilities.

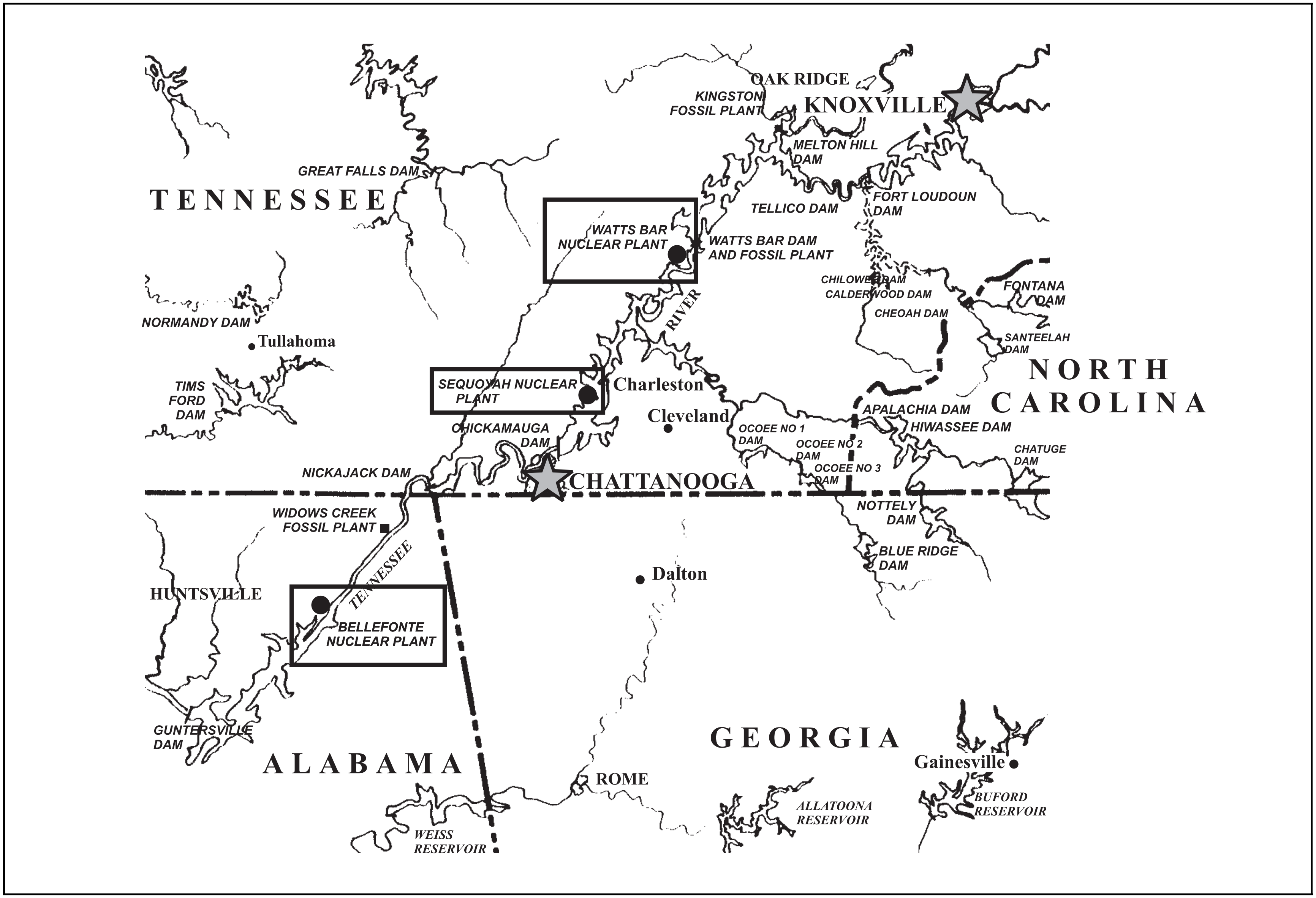


Figure S–2 Locations of Candidate CLWRs for Tritium Production

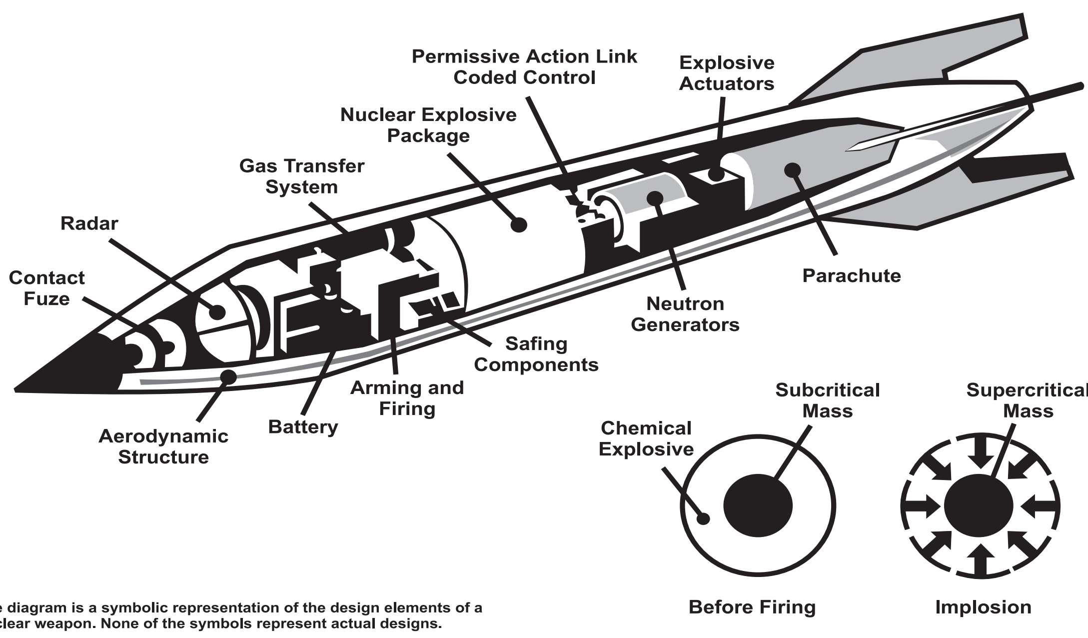
Tritium Use in a Nuclear Weapon

The figure below presents a simplified diagram of a modern nuclear weapon. An actual U.S. nuclear weapon is much more complicated, consisting of many thousands of parts.

The nuclear weapon primary is composed of a central core called a pit, which is usually made of plutonium-239 and/or highly enriched uranium. This is surrounded by a layer of high explosive, which, when detonated, compresses the pit initiating a nuclear reaction. This reaction is generally thought of as the nuclear fission "trigger" which activates the secondary assembly component to produce a thermonuclear hydrogen fusion reaction. The remaining nonnuclear components consist of everything from arming and firing systems, to batteries and parachutes. The assembly of these components into a weapon or the dismantlement of an existing weapon are done at the weapons assembly/disassembly facility.

Tritium is not a fissile material and cannot be used by itself to construct a nuclear weapon. However, tritium is a key component of all nuclear weapons presently in the nation's nuclear weapons arsenal. Tritium enables weapons to produce a larger yield while reducing the overall size and weight of the warhead. This process is called "boosting." Boosting is accomplished by injecting a mixture of tritium gas and deuterium gas, a naturally occurring, nonradioactive hydrogen isotope, into the pit. The deuterium and tritium are stored in reservoirs (which is depicted as the "gas transfer system" in the figure) until the gas transfer system is initiated. The implosion of the pit along with the onset of the fissioning process heats the deuterium-tritium mixture to the point that the atoms undergo fusion. The fusion reaction releases large quantities of very high energy neutrons which flow through the compressed pit material and produce additional fission reactions. Such boosting has allowed for the development of today's sophisticated delivery systems. The key function of tritium is to enhance the fission yield of a nuclear weapon.

Diagram of a Modern Nuclear Weapon



The diagram is a symbolic representation of the design elements of a nuclear weapon. None of the symbols represent actual designs.

Additionally, in 1991 President Bush declared a moratorium on underground nuclear testing, and in 1995 President Clinton decided to pursue a zero-yield Comprehensive Test Ban Treaty. Despite these significant changes, DOE's responsibilities for the nuclear weapons stockpile continue, and the President and Congress have directed DOE to continue to maintain the safety and reliability of the nuclear weapons stockpile and to provide the tritium necessary to satisfy national security requirements. As explained in Section S.2, the United States will need a new tritium production source by approximately 2005.

In the absence of new weapons designs and the total redesign of all warheads and delivery systems, the nation requires a reliable source of tritium to maintain a nuclear deterrent. Furthermore, total redesign of all warheads would require nuclear testing, which would be contrary to the President's pursuit of a Comprehensive Test Ban Treaty.

S.1.5.2 Brief History of the Production of Tritium

Tritium is so rare in nature that useful quantities must be manufactured. DOE has constructed and operated over a dozen nuclear reactors for the production of nuclear materials at the Savannah River Site, South Carolina, and the Hanford Site, Washington, starting with the early part of the Manhattan Project during World War II. None of these reactors is currently operational. The last one, the K-Reactor at the Savannah River Site, was shut down in 1988 for major environmental, safety, and health upgrades to comply with today's stringent standards. DOE discontinued the K-Reactor Restart Program in 1993 when smaller stockpile requirements delayed the need for tritium. As explained in the *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling*, the K-Reactor is not a reasonable alternative for tritium production.

In recent years, international arms control agreements have caused the nuclear weapons stockpile to be reduced in size. Reducing the stockpile has allowed DOE to recycle the tritium removed from dismantled weapons for use in supporting the remaining stockpile. However, due to the decay of tritium, the current inventory of tritium will not meet national security requirements past approximately 2005. Therefore, the most recent Presidential direction, contained in the 1996 Nuclear Weapons Stockpile Plan and an accompanying Presidential Decision Directive, mandates that new tritium be available by approximately 2005.

S.1.5.3 Production of Tritium in a CLWR

The production of tritium in a CLWR is technically straightforward and requires no elaborate, complex engineering development and testing program. All the nation's supply of tritium, as mentioned previously, has been produced in reactors. Most existing commercial pressurized water reactors utilize 12-foot-long rods containing an isotope of boron (boron-10) in ceramic form. These rods are sometimes called burnable absorber rods. The rods are inserted in the reactor fuel assemblies to absorb excess neutrons produced by the uranium fuel in the fission process for the purpose of controlling power in the core at the beginning of an operating cycle. DOE's tritium program has developed another type of burnable absorber rod in which neutrons are absorbed by a lithium aluminate ceramic rather than boron ceramic. These TPBARs would be placed in the same locations in the reactor core as the standard burnable absorber rods. There is no fissile material (uranium or plutonium) in the TPBARs.

While the two types of rods function in a very similar manner to absorb excess neutrons in the reactor core, there is one notable difference: when neutrons strike the lithium aluminate ceramic material in a TPBAR, tritium is produced. This tritium is captured almost instantaneously in a solid zirconium material in the rod, called a "getter." The solid material that captures the tritium as it is produced in the rod is so effective that the rod will have to be heated in a vacuum at much higher temperatures than normally occur in the operation of a light water reactor to extract the tritium for eventual use in the nuclear weapons stockpile. Depending upon tritium needs, as many as 3,400 TPBARs could be placed in a CLWR for irradiation.

S.1.5.4 Nonproliferation

Nuclear proliferation refers to the spread of nuclear weapons to nonnuclear weapons states. In an effort to limit nuclear proliferation, the United States, along with other signatories to the Nuclear Nonproliferation Treaty, has sought to preclude nonnuclear-weapons states from acquiring fissile materials (highly enriched uranium or plutonium) for weapons or explosive use. Under the terms of the Nuclear Nonproliferation Treaty, the United States is a weapons state and, as such, is allowed to conduct nuclear weapons activities. The production of tritium is one such activity. Accordingly, the use of a CLWR for the production of tritium is not inconsistent with the terms of the Nuclear Nonproliferation Treaty.

Along with other weapons-state signatories to the Nuclear Nonproliferation Treaty, the United States, under Article VI, undertakes to pursue negotiations or nuclear disarmament. Production of tritium in a CLWR in no way conflicts with these commitments. Since the end of the Cold War, the United States has significantly reduced the size of its nuclear weapons stockpile. At the present time, the United States is further downsizing the nuclear weapons stockpile consistent with the terms of the Strategic Arms Reduction Treaty (START) I Treaty. The United States has ratified the START II Treaty and is hopeful Russia also will ratify this treaty soon. Additionally, the United States has ceased production of fissile materials and the manufacture of new-design nuclear weapons and has closed several weapons production facilities.

Negotiations required for further reductions in United States nuclear weapons and, ultimately, total nuclear disarmament, will likely stretch well into the next century. United States production of tritium in a CLWR will support the U.S. nuclear weapons stockpile during this process. Such support of a decreased nuclear weapons stockpile is not inconsistent with the long-range goal of total nuclear disarmament.

The International Atomic Energy Agency (IAEA) is charged with detecting and deterring the spread of nuclear weapons. The United States has offered its commercial power plants to be inspected by the IAEA as an act of good faith and to encourage other nations to be equally open about their nuclear programs. Commercial reactor tritium production would not change this commitment. The commercial reactors would remain open for IAEA inspection whether they are producing tritium or not. Furthermore, the IAEA has indicated that CLWR production of tritium would not alter the existing IAEA Safeguards Program.

In accordance with the direction provided in the Fiscal Year 1998 National Defense Authorization Act (P.L. 105-85) conference report, DOE facilitated a high level interagency review of the policy issues associated with the use of commercial reactors to make tritium for national security purposes. Participants in the interagency review included the NRC, the U.S. Department of Defense, and the U.S. Department of State Arms Control offices. This process was completed in July 1998 and is documented in the *Interagency Review of the Nonproliferation Implications of Alternative Tritium Production Technologies Under Consideration by the Department of Energy, A Report to the Congress.* The report concluded that the nonproliferation policy issues associated with the use of a CLWR are manageable and that DOE should continue to pursue the reactor option as a viable source for future tritium production. This conclusion was based upon a number of considerations including the following:

1. The use of CLWRs for tritium production is not prohibited by law or international treaty.

2. Historically, there have been numerous exceptions to the practice of differentiating between U.S. civil and military facilities, including the operation of the N-Reactor at Hanford, Washington, the dual use nature of the U.S. enrichment program, the use of defense program plutonium production reactors to produce radioisotopes for civilian purposes, and the sale of tritium produced in the defense reactors in the U.S. commercial market.

3. Although the CLWR alternative raised initial concerns because of its implications for the policy of maintaining separation between U.S. civil and military nuclear activities, these concerns could be adequately addressed, given the particular circumstances involved. These circumstances include the fact that the reactors would remain eligible for IAEA safeguards and the fact that, if TVA were the utility selected for the tritium mission, the reactors used for tritium production would be owned and operated by the U.S. Government, making them roughly comparable to past instances of government-owned dual-purpose nuclear facilities.

In addition to those examples referred to in the *Interagency Review of the Nonproliferation Implications of Alternative Tritium Production Technologies Under Consideration by the Department of Energy*, there are other instances in which military nuclear programs have been commingled with civilian programs. These instances include: (1) Atomic Energy Commission purchase of plutonium separated from commercial reactor spent fuel for unrestricted use, including defense purposes; (2) fabrication of both military and commercial reactor fuel by commercial reactor fuel fabricators; and (3) TVA generation of electricity for use in the production of fissile military materials.

S.1.5.5 Background on the Tennessee Valley Authority

TVA was established by an Act of Congress in 1933 (16 U.S.C. 831-831dd) as a Federal corporation to improve the navigability of and provide flood control for the Tennessee River; to provide reforestation and ensure the proper use of marginal lands in the Tennessee Valley; to provide agricultural and industrial development of the Tennessee Valley; to provide for the national defense; and for other purposes. Within a few years of its establishment, TVA built a series of multipurpose dams on the Tennessee River system. One of the purposes of these dams was production of abundant, inexpensive electricity. The hydroelectric power generated by these dams met most of the rapidly increasing needs of the region through the 1940s. By the early 1950s, however, the growing demand was quickly outstripping the capacity of the dams and the Watts Bar Fossil Fuel Plant, which began operation in 1942. During the next 20 years, TVA built 11 large, coal-fired, electricity-generating plants to meet the region's growing needs. Some of these plants were the largest, first-of-their-kind coal-fired units in the world. The 1960s brought even greater growth to the region. To meet the anticipated need for more power, TVA began an ambitious program of nuclear plant construction.

Today TVA is one of the largest producers of electricity in the United States, generating 4 to 5 percent of all electricity in the nation. TVA's power system serves almost 8 million people in a seven-state region encompassing some 207,200 square kilometers (80,000 square miles). TVA's electricity is distributed to homes and businesses through a network of 159 power distributors, including municipally owned utilities and electric cooperatives. TVA also sells power directly to approximately 60 large industrial customers and Federal facilities.

TVA's power system, which is self-financed, has a generating capacity of 28,000 megawatts-electric. Its generating system consists of 11 coal-fired plants (53 percent of total generating capacity), 5 nuclear generating units at three sites (20 percent), 29 hydroelectric dams (15 percent), 48 combustion turbine units at four sites (7 percent), and one pumped-storage facility (5 percent). These plants are owned and operated by the U.S.

Government. The TVA power system is linked by 25,750 kilometers (16,000 miles) of transmission lines that carry power to 750 wholesale delivery points, as well as 57 interconnections with 13 neighboring utilities.

In December 1995, with the publication of *Energy Vision 2020, Integrated Resource Plan and Environmental Impact Statement*, TVA projected demands for electricity in the TVA power service area through the year 2020 and evaluated different ways of meeting these projected increases. Since the Integrated Resource Plan was completed in 1995, TVA has continued to evaluate and select the best resource options based on the latest proposals and TVA's forecast of power needs. The total system generating capacity has been increased with the successful completion of Watts Bar 1 and the return to service of Browns Ferry Nuclear Plant Unit 3. Both units have operated above expectations and have proven to be very reliable.

Current projections show the demand for electricity (including reserves) will exceed TVA's 1998 generating capacity by about 5,200 megawatts-electric in 2005; this projection is slightly less than the 1998-2005 medium load forecast of 5,450 megawatts-electric in *Energy Vision 2020, Integrated Resource Plan and Environmental Impact Statement*. About 2,800 megawatts-electric of additional generating capacity will be needed by the year 2001. A portion of this could be met by the proposed Red Hills Power Project. The remainder will be met by option purchase agreements, forward contracts for delivery of electricity to TVA, and internal TVA projects to increase net dependable capacities for TVA's combustion turbines, fossil plants, and pumped storage units. An additional 2,400 megawatts-electric of capacity will be required between 2001 and 2005. The completion of the Bellefonte unit(s) would offset some of this planned capacity.

Producing tritium in a TVA reactor would be consistent with the Congressional purposes that established TVA—namely, to provide for the industrial development of the Tennessee Valley and for national defense. Producing tritium in a TVA reactor would also enable TVA to maximize the utilization of its resources and potentially increase its electricity generating capacity. TVA, as a Federal agency, in order to fulfill NEPA responsibilities, chose to be a cooperating agency on this EIS. A cooperating agency is defined by Council on Environmental Quality regulations as any Federal agency other than a lead agency having jurisdiction by law or special expertise with respect to any environmental issue involved in a proposal (40 CFR 1508.5).

S.1.6 NEPA Strategy

DOE's strategy for compliance with NEPA has been to make decisions on programmatic alternatives in the *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* and the subsequent Record of Decision (60 FR 63878), followed by site-specific analyses to implement the programmatic decisions. The decisions made in the December 12, 1995 *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* Record of Decision have resulted in DOE preparing this EIS and the following NEPA documents:

1. *Environmental Impact Statement, Construction and Operation of a Tritium Extraction Facility at the Savannah River Site*

2. *Environmental Impact Statement, Accelerator Production of Tritium at the Savannah River Site*

3. *Environmental Assessment, Lead Test Assembly Irradiation and Analysis, Watts Bar Nuclear Plant, Tennessee and Hanford Site, Richland, Washington*

The relationship of the CLWR EIS with these, as well as other relevant NEPA documents, is explained below.

S.1.6.1 Completed NEPA Actions

S.1.6.1.1 Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling

The *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling*, DOE/EIS-0161, evaluated the alternatives for the siting, construction, and operation of tritium supply and recycling facilities at each of five DOE candidate sites (the Idaho National Engineering and Environmental Laboratory; the Nevada Test Site; the Oak Ridge Reservation, Tennessee; the Pantex Plant, Texas; and the Savannah River Site, South Carolina) for four different production technologies (heavy water reactor, modular high temperature gas-cooled reactor, advanced light water reactor, and accelerator production of tritium). This Programmatic EIS also evaluated the impacts of using a CLWR, but did not analyze specific locations or reactor sites. Issued in October 1995, the Final Programmatic EIS was followed by a Record of Decision on December 12, 1995 (60 FR 63878). In the Record of Decision, DOE decided to pursue a dual-track approach on the two most promising tritium supply alternatives: (1) to initiate purchase of an existing commercial reactor (operating or partially complete) or reactor irradiation services with an option to purchase the reactor for conversion to a defense facility; and (2) to design, build, and test critical components of an accelerator system for tritium production (the Savannah River Site was selected as the location for an accelerator, should one be built) (60 FR 63878). The Record of Decision also called for the construction of a proposed new Tritium Extraction Facility at the Savannah River Site. The CLWR EIS is intended to provide the NEPA analysis necessary to implement the Final Programmatic EIS Record of Decision, which will select the technology and specific site for a tritium production facility.

On December 22, 1998, Energy Secretary Richardson announced that tritium production in one or more CLWRs would be the United States' primary tritium supply technology and that the accelerator would be developed, but not constructed, as a backup to CLWR tritium production. Secretary Richardson further stated that the Watts Bar and Sequoyah reactors have been designated as the Preferred Alternative for CLWR tritium production. The Secretary's announcement that the CLWR would be the primary tritium technology reaffirms the 1995 Record of Decision for the Final Programmatic EIS to construct and operate a new tritium extraction capability at the Savannah River Site.

S.1.6.1.2 Lead Test Assembly Environmental Assessment

This NEPA analysis addressed the environmental impacts associated with the fabrication of the Lead Test Assembly TPBARs at Pacific Northwest National Laboratory, Washington; the irradiation of these TPBARs in Watts Bar 1; post-irradiation examination of the TPBARs at Pacific Northwest National Laboratory and Argonne National Laboratory West, Idaho; and associated impacts of transporting TPBARs to and from the Watts Bar Nuclear Plant. The purpose of the Lead Test Assembly demonstration is to confirm and provide confidence to regulators and the public that tritium production in a CLWR is technically straightforward and safe. DOE issued a Finding of No Significant Impact in July 1997. Subsequently, the TPBARs were placed in Watts Bar 1 on September 25, 1997, and they are presently being irradiated during the normal 18-month fuel cycle. Following irradiation, the TPBARs will undergo post-irradiation examination. To meet its own NEPA requirements, TVA adopted the Lead Test Assembly Environmental Assessment and issued a Finding of No Significant Impact on August 14, 1997. Additionally, NRC prepared an independent Environmental Assessment and issued its own Finding of No Significant Impact on September 11, 1997 (62 FR 47835).

Lead Test Assembly Program

In September 1997, a confirmatory demonstration using the TPBARs began at Watts Bar 1 following approval by DOE and NRC. The purpose of the confirmatory tests is to provide confidence to the NRC, utilities, and the public that tritium production in a CLWR is both technically straightforward and safe. DOE expects TVA to remove these rods in the Spring of 1999, at which time they will be shipped to a DOE laboratory for examination.

S.1.6.1.3 EISs for the Operation of Watts Bar 1 and Sequoyah 1 and 2 and for Construction of Bellefonte 1 and 2

EISs analyzing the environmental impacts associated with operation of the Watts Bar and Sequoyah Nuclear Plants and the construction of the Bellefonte Nuclear Plant have been completed and serve to a great extent as a baseline on which the environmental impacts associated with tritium production are assessed. For the partially completed Bellefonte 1 and 2, this CLWR EIS evaluates the environmental impacts associated with their completion and their subsequent operation for 40 years.

S.1.6.2 Ongoing NEPA Actions

S.1.6.2.1 Environmental Impact Statement, Accelerator Production of Tritium at the Savannah River Site

This EIS analyzes the potential environmental impacts associated with the construction and operation of an accelerator for the production of tritium at the Savannah River Site. On a programmatic level, the accelerator for the production of tritium at the Savannah River Site represents the No Action Alternative for the CLWR EIS. A summary of the APT Draft EIS, is included in Volume 1, Section 5.2.11, of the CLWR EIS. The Draft APT EIS was issued in December 1997. The Final EIS was issued concurrently with the CLWR Final EIS. As a result of the decision by Secretary Richardson on December 22, 1998, that the accelerator would be a backup to CLWR tritium production, DOE will continue with developmental activities associated with the accelerator. However, the accelerator will not be constructed. The APT EIS is incorporated in the CLWR EIS by reference.

S.1.6.2.2 Environmental Impact Statement, Construction and Operation of a Tritium Extraction Facility

This EIS analyzes the potential environmental impacts associated with the construction and operation of a Tritium Extraction Facility at the Savannah River Site. The Draft EIS for the Tritium Extraction Facility was issued in May 1998; a Final EIS was issued concurrently with the CLWR EIS. The purpose of the Tritium Extraction Facility would be to extract the tritium from the TPBARs or from targets of similar design. TPBARs irradiated at the selected CLWRs would be sent to the Tritium Extraction Facility for extraction of the tritium-containing gases. A summary of the environmental impacts of the *Environmental Impact Statement, Construction and Operation of a Tritium Extraction Facility at the Savannah River Site*, DOE/EIS-0271, is included in the CLWR EIS. The Tritium Extraction Facility EIS is incorporated in the CLWR EIS by reference.

S.1.6.2.3 Environmental Assessment for the Tritium Facility Modernization and Consolidation Project at the Savannah River Site

This environmental assessment addresses the potential impacts of consolidating the tritium activities currently performed in Building 232-H into the newer Building 234-H. Tritium extraction functions would be transferred to the Tritium Extraction Facility under the Preferred Alternative. The overall impact would be to reduce emissions by up to 50 percent. Another effect would be to reduce the amount of low-level radioactive waste generated. Effects on other resources would be negligible. Therefore, impacts from these actions were not included in the cumulative impacts of this CLWR EIS.

S.1.6.2.4 Final Environmental Impact Statement for the Bellefonte Conversion Project

This EIS, issued by TVA, addresses the environmental impacts anticipated from: (1) the conversion of the partially completed Bellefonte 1 and 2 to fossil fuel electricity generating facilities, and (2) the No Action Alternative of maintaining the facilities as partially completed nuclear facilities. The EIS was completed in October 1997. The issuance of a Record of Decision on the *Final Environmental Impact Statement for the Bellefonte Conversion Project* will not be made until it is determined whether one or both of these reactor plants will be used for tritium production.

S.1.7 Public Comment Period

In August 1998, DOE issued the CLWR Draft EIS (DOE/EIS-0288D). This document explained the need for a domestic tritium production source to maintain the U.S. nuclear deterrent and described and analyzed the environmental impacts associated with tritium production at one or more nuclear power plants operated by TVA. The 60-day public comment period on the CLWR Draft EIS began on August 28, 1998, and ended on October 27, 1998.

During the comment period, public hearings were held in North Augusta, South Carolina; Rainsville, Alabama; and Evensville, Tennessee. The public was encouraged to submit comments via the U.S. mail service, e-mail to a special DOE web site on the Internet, a toll-free 800-number phone line, and a toll-free fax line.

The public hearings were conducted using a modified traditional public hearing format that allowed two-way interaction between DOE representatives and members of the public and also encouraged public comments on the document. A neutral facilitator was present at each hearing to direct and clarify discussions and comments. A court reporter was present at each hearing to record the proceedings and provide a transcript of the public comments and the dialogue between the public and the DOE and TVA representatives.

Comments from the public hearings were combined with comments received by other means (mail, e-mail, 800 number, fax, etc.) during the comment period. The written comments were date-stamped and assigned a sequential document number in the order in which they were received. Volume 2 of this CLWR EIS, the Comment Response Document, describes the public comment process in detail (Chapter 1); provides scanned images of all the comment documents received (Chapter 2); summarizes the public hearing comments (Chapter 2); and provides DOE’s responses to the public comment summaries (Chapter 3).

Prior to fulfilling the requirement to reach a technology decision by the end of 1998, Energy Secretary Richardson asked TVA to submit final proposals for its Watts Bar and Sequoyah reactors, as well as for completion of its Bellefonte reactor. These proposals were provided to DOE the first week of December 1998, after the October 27, 1998, closing of the public comment period for the CLWR Draft EIS. After receiving these offers, Secretary Richardson directed that this information be presented to the public so they could review the latest TVA offers and provide their comments prior to his reaching the technology decision. To enable this, in spite of the short notice, a public meeting was scheduled and conducted on December 14, 1998. At this meeting, DOE presented information on the new proposals; answered questions; and accepted comments on the proposals, as well as on CLWR tritium production in general. The public was encouraged to comment on the new TVA proposals via U.S. mail, fax, toll-free 800-number phone line, or e-mail. Although the comments received as a result of this December 14, 1998, meeting were submitted after the public comment period, DOE responded to all of these comments as though they were received during the public comment period and they are included in Volume 2, the Comment Response Document.

During the public comment period, approximately 800 comments were received. An additional 230 comments were in conjunction with the December 14, 1998, public meeting. Most of the comments focused on a limited number of major issues. These issues and DOE's responses are summarized below.

By far, a majority of comments supported the completion and operation of the Bellefonte Nuclear Plant for tritium production because it would promote economic development in a depressed area and provide other, similar benefits. Other commentors generally opposed the completion of the Bellefonte plant as a nuclear power plant, particularly for tritium production. In response to these comments, DOE acknowledged there is both public support and opposition for the Bellefonte alternative. The CLWR EIS addresses all of the benefits cited by the commentors who favored the Bellefonte alternative, as well as the concerns expressed by opponents. DOE's response to these and other related comments may be found in Volume 2, Chapter 3 of this EIS, under Category 7: General Support/Opposition.

The cost-effectiveness of the CLWR and APT tritium production alternatives was another frequent theme among many commentors. Most asked for cost-related information and/or expressed the opinion that cost should be the major determining factor in a tritium production decision. In addition, some commentors questioned the accuracy of the cost information that DOE provided at the public hearings and the December 14, 1998, public meeting, and many believed there was little possibility that TVA could complete the Bellefonte plant for the cost estimates cited. Other commentors stated they felt the large expenditures required for CLWR tritium production would be better spent on other, more urgent social needs such as education and environmental restoration. Some commentors were concerned about possible costs to TVA ratepayers resulting from tritium production.

In response to the cost-related comments, DOE stated that the CLWR EIS was prepared in accordance with NEPA, the Council on Environmental Quality's regulations on implementing NEPA (40 CFR Parts 1500-1508), and DOE's NEPA regulations (10 CFR 1021). None of these regulations require the inclusion of a cost analysis in an EIS. As discussed in Volume 1, Chapter 3, Section 3.2.1, the basic objective of the CLWR EIS is to provide the public and DOE decisionmakers with a description of the reasonable alternatives for CLWR tritium production and information about their potential impacts on public health and safety and the environment. While costs could be an important factor in the ultimate Record of Decision, the purpose of this and other EISs is to address the environmental consequences of the proposed action. DOE distributed cost information comparing the CLWR and APT alternatives at the public hearings in October 1998, however, and this information is available upon request. In response to comments concerning the accuracy of TVA's cost estimates for completing the Bellefonte plant, DOE considers TVA's cost estimates to be both accurate and conservative, given that the plant is nearly complete and TVA's cost estimates were evaluated by an external reviewer. In response to comments that CLWR funds would be better spent on other, more urgent social needs, DOE noted that Congress determines how funds are allocated, and DOE does not determine Federal spending priorities. Furthermore, such spending priorities are beyond the scope of this EIS. In response to the concerns of TVA ratepayers about potential costs resulting from tritium production, DOE responded that no additional costs to ratepayers are expected. DOE's responses to the cost-related public comments are found in Volume 2, Chapter 3 of this EIS, under Category 23: Cost Issues.

Many commentors questioned the need for nuclear weapons and/or the present need for tritium. Other commentors expressed a belief that the amount of tritium needed to support current and future nuclear weapons stockpiles is less than the amount stated in the CLWR EIS. In response, DOE cited its responsibilities for maintaining the nation's nuclear weapons stockpile under the Atomic Energy Act of 1954 and the requirements of the 1996 Nuclear Weapons Stockpile Plan and accompanying Presidential Decision Directive, which established the size and composition of the nation's nuclear weapons stockpile and the need for a new tritium production source by approximately 2005. DOE stated that sufficient quantities of tritium no longer can be obtained from weapons being retired from the existing stockpile, as cited in the most recent Presidential

Decision Directive. DOE's responses to comments concerning the need for tritium are found in Volume 2, Chapter 3 of this EIS, under Category 2: Purpose and Need for Tritium.

Several commentors expressed concern that tritium production in a commercial reactor would violate U.S. policy regarding the separation of commercial and military uses of nuclear energy, would hinder nonproliferation efforts, and would encourage other nations to use their own commercial facilities for nuclear weapons purposes. In response to these concerns, DOE cited the conclusions of a high-level study entitled, *Interagency Review of the Nonproliferation Implications of Alternative Tritium Production Technologies Under Consideration by the Department of Energy, A Report to the Congress.* This interagency review concluded that any nonproliferation issues associated with the production of tritium in a CLWR were manageable and that DOE should continue to pursue the CLWR option, as stated in Volume 1, Chapter 1, Section 1.3.5, of the CLWR EIS. DOE also stated that there is no U.S. policy, law, or treaty that prohibits the production of tritium that ultimately will be used in weapons in a commercial reactor. In addition, DOE stated that the United States is a declared weapons state, and the purpose of nonproliferation efforts is to keep nonweapons states from acquiring nuclear weapons while the declared weapons states work toward total disarmament. DOE noted that other nations already operate dual-purpose reactors that serve both civilian and military needs. DOE's responses to comments on nonproliferation, the separation of civilian and military nuclear facilities, and other policy issues are found in Volume 2, Chapter 3 of this EIS, under Category 1, Policy Issues.

Many commentors were concerned with public and occupational health and safety issues. Some specifically questioned TVA's past history and practices related to plant safety. In response to these concerns, DOE stated that the environmental impacts and potential radiological doses to both workers and the public resulting from tritium production would be well below the limits considered acceptable by Federal and state regulatory authorities. Public and occupational health and safety issues are discussed in Volume 1, Chapter 5, of the CLWR EIS. DOE also stated that prior to irradiation of any TPBARs, an NRC safety evaluation would be required to amend the operating license of the reactors for tritium production. This review specifically would look at all potential health and safety issues. DOE's responses to public and occupational health and safety comments are found in Volume 2, Chapter 3 of this EIS, under Category 14: Occupational and Public Health and Safety - Normal Conditions.

Several commentors stated that DOE has a history of polluting and contaminating every site they have operated and wanted to know why the proposed action would be any different. In response, DOE acknowledged having a number of older facilities in need of environmental cleanup, and an aggressive cleanup program is underway to upgrade these facilities and ensure their continued compliance with Federal and state regulations. All of the CLWR tritium production alternatives involve the use of state-of-the-art TVA reactors. These reactors have excellent environmental compliance records and exemplary environmental, health, and safety programs to ensure their continued compliance with Federal and state regulations. In addition, DOE expressed confidence that tritium production in a CLWR would be safe and is technically straightforward. To commentors who expressed concern that CLWR tritium production expenditures would drain DOE's budget for its facility cleanup activities, DOE responded that the funding for both of these programs would come from separate Congressional appropriations. Funding for CLWR tritium production would not be obtained from funding already allocated for facility cleanup activities. DOE's responses to comments about past DOE practices and conflicts between DOE's cleanup activities and tritium production are found in Volume 2, Chapter 3 of this EIS, under Category 8: Past DOE Practices.

Some commentors suggested that the CLWR EIS was deficient and inadequate as a NEPA document. In response, DOE stated that it believes that the EIS is adequate and fully complies with NEPA. The EIS evaluates all reasonably foreseeable environmental impacts for all reasonable alternatives, in accordance with the requirements of the Council on Environmental Quality's regulations (40 CFR 1500-1508) and DOE's

NEPA regulations (10 CFR 1021) and procedures. DOE's responses to NEPA-related comments are found in Volume 2, Chapter 3 of this EIS, under Category 5: NEPA Process.

Other commentors stated that the relationship between the CLWR , APT, and Tritium Extraction Facility EISs was not clearly explained in the CLWR Draft EIS. In response, DOE added a Preface to the CLWR Final EIS to better describe the relationship between the CLWR EIS, the APT EIS, and the Tritium Extraction Facility EIS. This Preface also addresses Energy Secretary Richardson's December 22, 1998, announcement that the CLWR would be the primary tritium supply technology. DOE's response to comments concerning the relationship between the CLWR , APT, and Tritium Extraction Facility EISs is found in Volume 2, Chapter 3 of this EIS, under Category 5: NEPA Process (Comment Summary 05.01).

Several commentors were concerned about the additional spent nuclear fuel that would be generated by tritium production. DOE responded that additional spent nuclear fuel would be generated if more than 2,000 TPBARs were irradiated in a single reactor, as stated in Section 3.2.1, Volume 1, of the CLWR Final EIS. DOE also stated that the CLWR EIS evaluates the environmental impacts of additional spent fuel generation resulting from a maximum number of 3,400 TPBARs. DOE stated that it would manage the tritium production process to minimize, to the extent practicable, the generation of additional spent nuclear fuel. In the event a suitable repository is not available, as required by law, the additional spent nuclear fuel generated as a result of tritium production would be stored on site in a dry cask independent spent fuel storage installation. DOE's responses to spent nuclear fuel comments are found in Volume 2, Chapter 3 of this EIS, under Category 17: Spent Fuel Management.

Several commentors suggested that the production of tritium in a CLWR would make TVA reactors an attractive target for terrorists and that DOE should address the consequences of such an attack in the EIS. In response, DOE stated that, prior to loading TPBARs in TVA's Watts Bar reactor as part of the Lead Test Assembly Program, a thorough security review was conducted. This review found existing security provisions to be adequate to protect against such a threat. Prior to utilizing Watts Bar or other TVA reactors for tritium production, additional DOE and NRC reviews would be required to ensure safeguard and security provisions are adequate. DOE's responses to these and other security-related comments are found in Volume 2, Chapter 3 of this EIS, under Category 22: Safeguards and Security.

S.1.8 Changes from the Draft Environmental Impact Statement

In response to comments on the CLWR Draft EIS and as a result of information that was unavailable at the time of the issuance of the Draft, Volume 1 of the CLWR Final EIS contains revisions and new information. These revisions and new information are indicated by a double underline for minor word changes or by a sidebar in the margin for sentence or larger additions. Volume 2, Comment Response Document, contains the comments received during public review of the CLWR Draft EIS and DOE's responses to those comments. A brief discussion of the most important changes is provided in the following paragraphs.

TPBAR Failures

In analyzing the potential releases of tritium to the environment from the proposed action, the CLWR Draft EIS assumed that two of the TPBARs under irradiation would fail and the entire inventory of tritium would be available to be released to the environment under normal operating conditions. The same two-TPBARs failure assumption was made in the analysis of transportation accidents. The assumption was based on the failure statistics of standard burnable absorber rods, i.e., two failures out of 29,700 rods through July 1980. Since the issuance of the CLWR Draft EIS, additional information obtained from Westinghouse revealed that both failures were attributed to early manufacturing defects that have been corrected. The failures were attributed to slumping of the absorber material—a condition that cannot occur in the TPBARs. Since the two early failures, more than 500,000 Westinghouse burnable absorber rods have been used without a single observed failure. Consequently, the CLWR Final EIS still analyzes the impacts to the health and safety of the public from the potential failure of two TPBARs, but characterizes the event of such a failure as an abnormal event during an irradiation cycle, rather than a continuous, normal-operation occurrence. This change in assumptions results in changes in the potential tritium releases and estimated doses to the public under normal reactor operation and some accident conditions (i.e., the nonreactor design-basis accident) for all reactor alternatives.

The Secretary's Technology Announcement

The CLWR Draft EIS was issued in August 1998. At the time, the decision on the primary and backup technologies to be used for tritium production had not been made. On December 22, 1998, Energy Secretary Bill Richardson announced that the CLWR would be DOE's primary option for tritium production and the proposed linear accelerator at the Savannah River Site would be the backup option. In addition, the Secretary designated TVA's Watts Bar and Sequoyah Nuclear Plants as the preferred CLWR facilities. The CLWR Final EIS was revised to reflect the Secretary's announcement and include the Preferred Alternative. Changes were made primarily in the introductory sections of the CLWR Final EIS for accuracy. The evaluation of the impacts was not affected.

Clarification of TVA Proposals

In response to public comments about the status of the TVA proposals to provide irradiation services or the sale of a CLWR, Section 1.1.4 was revised. The discussion of the procurement process clarifies that DOE is considering only the purchase of irradiation services, not the purchase of a reactor. Additionally, the section clarifies that TVA submitted several proposals to DOE during the ongoing negotiations. An earlier TVA proposal for the use of Watts Bar expired. However, in December 1998, TVA submitted to DOE another offer to provide irradiation services at Watts Bar and Sequoyah, as well as additional proposals for Bellefonte. TVA's offer to provide irradiation services at one or more of the three proposed sites is still viable.

Nonproliferation Policy Issues

In response to public comments requesting DOE to provide examples of the commingling of civilian nuclear programs with military nuclear programs, Section 1.3.5 was revised. The discussion of nonproliferation now includes an explanation and some background information on the issue, as well as examples of the commingling of civilian and military uses of nuclear power.

Water Quality Analysis

In response to public comments expressing concern about impacts to public water withdrawals downstream of the Bellefonte Nuclear Plant, sections of Chapters 4 and 5 were revised. The discussion of surface water use for Bellefonte (Section 4.2.3.4) identifies nearby intakes downstream. The discussions of potential impacts to surface water near the three reactor sites (Sections 5.2.1.4, 5.2.2.4, and 5.2.3.4) include the tritium concentration at various locations downstream. In addition, Section 5.2.3.4 was revised to include potential chemical concentrations downstream of Bellefonte.

Accident Analysis

During the preparation of the CLWR Final EIS, data related to the design and fabrication of the TPBARs indicated that the release of tritium from an accidental breach of a TPBAR more likely would be time-dependent than instantaneous and finite, as was assumed in the Draft EIS. Consequently, the analysis for the

TPBAR handling accident and the transportation cask handling accident at the reactor site (Appendix D), and the transportation cask accident en route (Appendix E), were revised to reflect the more recent data.

Environmental Justice

Figures in Appendix G were revised to improve their quality. New figures were added to show the location of minority and low-income populations within a 16.1-kilometer (10-mile) radius. In addition, a representative average individual dose at 40.2 kilometers (25 miles) to each of the 16 principal directions has been overlaid onto the 80.5-kilometer (50-mile) radius to show the potential dose to minority and low-income populations.

Tritium Requirements and Supply

In response to public comments expressing concerns about the disparity between the amount of tritium needed and the amount that could be supplied by one CLWR, Section 3.2.1 was revised. The discussion explains that the exact amount of tritium needed is classified information, however, for the purposes of analysis, it is not expected to exceed 3 kilograms per year (6.6 pounds per year). It further clarifies that one reactor with 3,400 TPBARs would be expected to satisfy a steady state tritium requirement in most years.

Comparison of the APT and CLWR Alternatives

In response to public comments requesting additional information about the No Action Alternative, Section 3.2.6 was expanded to include a table comparing the impacts of producing tritium under the accelerator and CLWR options. A document comparing the costs of the technology options is available upon request from DOE.

Source of Uranium-235 for Tritium Production

In response to public comments concerning the source of blended-down uranium-235 that could be used as nuclear fuel for tritium production, Section 5.2.7 was revised for clarification. A discussion of the environmental impacts resulting from blending-down activities of highly enriched uranium was also added.

Mitigation Measures

The CLWR Draft EIS discusses the need for mitigation measures, if such a need were warranted, right after the presentation of the impacts for each environmental resource. A new Section 5.5 was added to the CLWR Final EIS to summarize these discussions.

Sensitivity Analysis

An additional variation from the baseline analysis has been included in Section 5.2.9 of the CLWR EIS, that is, the possibility of producing tritium at some date later than 2005.

Miscellaneous Revisions and Editorial Changes

Several sections in the CLWR Final EIS were revised to reflect the availability of more recent data, or to include corrections on erroneous information, improvements in the presentation, and other editorial changes. None of these revisions affect the environmental impact assessment of the EIS.

S.2 Purpose and Need

Since nuclear weapons came into existence in 1945, a nuclear deterrent has been a cornerstone of the nation's defense policy and national security. Both President Clinton and the Congress have reiterated this principle in public statements and through legislation. The President has stated on a number of occasions his commitment to maintaining a nuclear deterrent capability. Most recently, in May 1997, the President stated in *A National Security Strategy for a New Century* that, ". . . our nuclear deterrent posture is one of the most visible and important examples of how U.S. military capabilities can be used effectively to deter aggression and coercion. Nuclear weapons serve as a hedge against an uncertain future, a guarantee of our security commitments to allies, and a disincentive to those who would contemplate developing or otherwise acquiring their own nuclear weapons."

U.S. strategic nuclear systems are based on designs that use tritium gas. Since tritium decays at a rate of about 5.5 percent per year (i.e., every 12.3 years one-half of the tritium has decayed), periodic replacement is required as long as the United States relies on a nuclear deterrent. The nation, therefore, requires a reliable source of tritium to maintain its nuclear weapons stockpile.

The size of the nation's nuclear weapons stockpile is determined by the Secretaries of Defense and Energy who, in coordination with the Nuclear Weapons Council, jointly sign and submit to the President the Nuclear Weapons Stockpile Memorandum. This Memorandum transmits the Nuclear Weapons Stockpile Plan to the President for final approval. Many factors are considered in the development of the Nuclear Weapons Stockpile Plan, including the status of the currently approved stockpile, arms control negotiations and treaties, Congressional constraints, and the status of the nuclear material production and fabrication facilities. Under this plan, DOE can determine the amount of tritium necessary to support the approved stockpile.

Over the past 40 years, DOE has built and operated over a dozen nuclear reactors (five of them at the Savannah River Site in South Carolina) to produce tritium and other nuclear materials for weapons purposes. Today, none of these reactors are operational, and DOE has not produced tritium for addition to the stockpile since 1988. According to the Atomic Energy Act of 1954, however, DOE is responsible for developing and maintaining the capability to produce the nuclear materials, such as tritium, that are necessary for the defense of the United States (40 U.S.C. 2011).

Until a new tritium supply source is operational, DOE will continue to support tritium requirements by recycling tritium from weapons retired from the nation's stockpile. However, because of the tritium decay rate, recycling can only meet the tritium demands for a limited time, even with the reduction in stockpile requirements and no identified need for new-design weapons in the foreseeable future. Current projections, derived from the most recently approved, classified projections of future stockpile scenarios, indicate that recycled tritium will support the nation's nuclear weapons stockpile adequately until approximately 2005 (see **Figure S–3**).

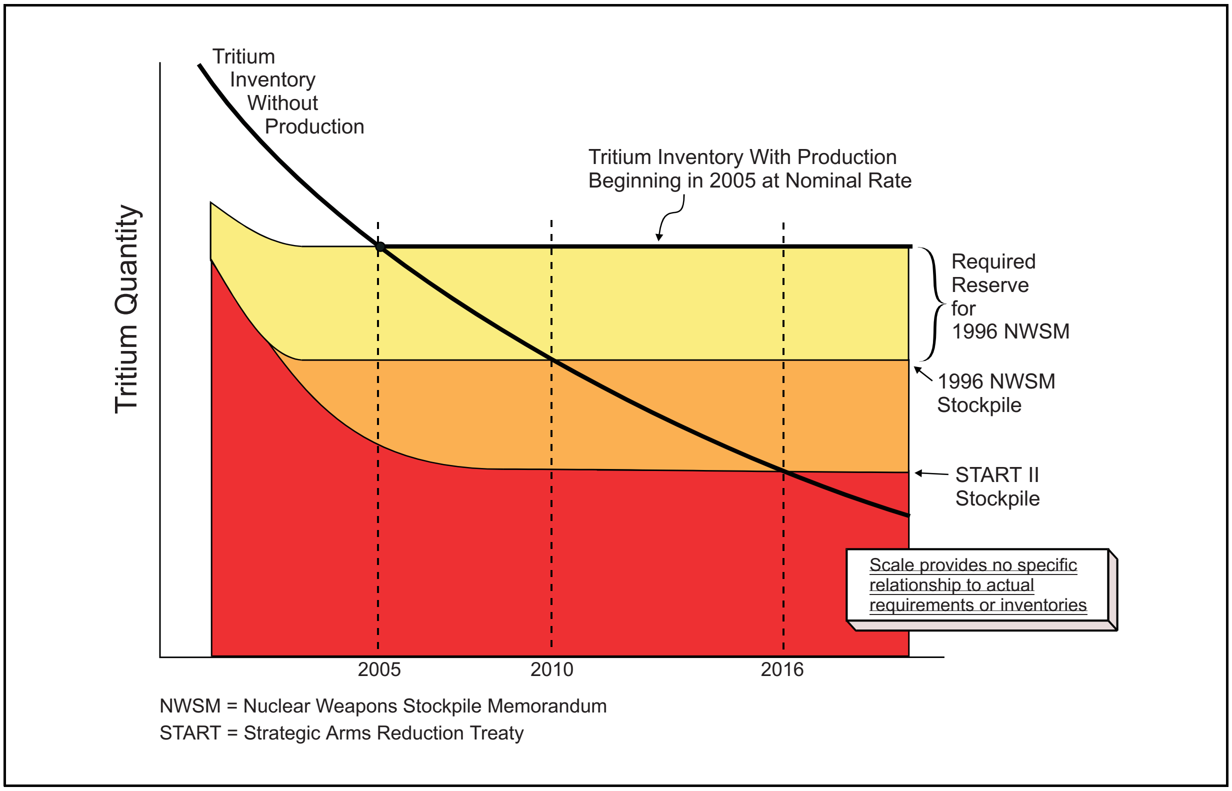


Figure S–3 Estimated Tritium Inventory and Reserve Requirements

Even with a reduced nuclear weapons stockpile and no identified requirement for new nuclear weapons production in the foreseeable future, an ensured long-term tritium supply and recycling capability will be required to maintain the weapons determined to be needed for national defense under the prevailing Nuclear Weapons Stockpile Plan. Presently, no U.S. source of new tritium is available. The effectiveness of the U.S. nuclear deterrent capability depends not only on the nation's current stockpile of nuclear weapons or the effectiveness of those it can produce, but also on its ability to reliably and safely provide the tritium needed to maintain these weapons.

To meet requirements mandated by the President and supported by the Congress, the United States will need a new source of tritium production by approximately 2005. For planning purposes, the operational life of the new production source would be about 40 years. Without a new supply source, after 2005 the United States would have to use its five-year reserve of tritium to maintain the readiness of the nuclear weapons stockpile. The five-year reserve contains a quantity of tritium maintained for emergencies and contingencies. In such a scenario, the complete depletion of the five-year tritium reserve would degrade the nuclear deterrent capability because not all weapons in the stockpile would be able to function as designed. Eventually, the United States would lose its nuclear deterrent. The purpose of DOE's action is to produce in one or more commercial light water reactors, the tritium needed to maintain the nation's nuclear weapons stockpile.

TVA's purpose and need relative to this EIS is to maximize the utilization of its resources while simultaneously providing support to national defense. National defense support has been one of TVA's historic multi-purpose missions (see Section S.1.5.5).

S.3 COMMERCIAL LIGHT WATER REACTOR PROGRAM ALTERNATIVES

S.3.1 Production of Tritium in a Commercial Light Water Reactor

To produce tritium in a CLWR, TPBARs would be inserted into the reactor core. The TPBARs are long, thin tubes that contain lithium-6, a material that produces tritium when it is exposed to neutrons in the reactor core. The exterior dimensions of the TPBARs are similar to the burnable absorber rods, so that they can be installed in fuel assemblies where burnable absorber rods are normally placed. To ease the insertion and removal from fuel assemblies, the TPBARs would be attached to a base plate. See **Figures S–4** and **S–5** for a sketch of a typical TPBAR assembly and components. In addition to producing tritium, TPBARs would fill the same role as burnable absorber rods in the operation of the reactor.

The neutron absorber material in the TPBARs would be enriched in the isotope lithium-6, instead of the boron usually used in the burnable absorber rods. When the TPBARs are inserted into the reactor core, neutrons would be absorbed by the lithium-6 isotope, thereby initiating a nuclear process that would turn it into lithium-7. The new isotope would then split to form helium 4 and tritium (see Appendix A for a more detailed discussion of this process). The tritium then would be captured in a solid metal nickel-plated zirconium material in the TPBAR called a "getter." The tritium would be chemically bound in the TPBAR "getter" until the TPBAR is removed from the reactor during refueling and transported to the proposed Tritium Extraction Facility at the U.S. Department of Energy's (DOE) Savannah River Site in South Carolina. There the tritium would be extracted by heating the TPBARs in a vacuum to temperatures in excess of 1,000 degrees Centigrade (°C) (1,800 degrees Fahrenheit [°F]). Following extraction, the tritium would be purified.

S.3.1.1 Impacts of Tritium Production on Reactor Operations

The replacement of burnable absorber rods with TPBARs should have few impacts on the normal operation of the reactor. The normal power distribution within the core and reactor coolant flow and its distribution within the core would remain within existing technical specification limits. Some tritium is expected to permeate through the TPBARs during normal operation, which would increase the quantity of tritium in the reactor's coolant water system. Since tritium is a type, or isotope, of the hydrogen atom, once the tritium is in the reactor's coolant water system, it could combine with oxygen to become part of a water molecule and could eventually be released to the environment.

The operational differences between a tritium production reactor and a nuclear power plant without tritium production were determined by evaluating each environmental resource area and identifying the operational parameters that would change in a typical CLWR as a result of operating in a tritium production mode. The summarized operational differences are:

- Accident conditions—The physical changes to the reactor core would involve replacing some burnable absorber rods with TPBARs. This change would increase the estimated quantity of radionuclides assumed to be released in the analysis.

- Personnel—Additional TPBAR handling and shipping activities would create new jobs and possibly require the hiring of extra personnel at the CLWR sites.

- Effluent—The tritium content in the liquid effluent and gaseous emissions is expected to increase as a result of the presence of TPBARs in the reactor.

- Waste—Additional activities associated with handling, processing, and shipping TPBAR assemblies are expected to increase low-level radioactive waste generation rates.

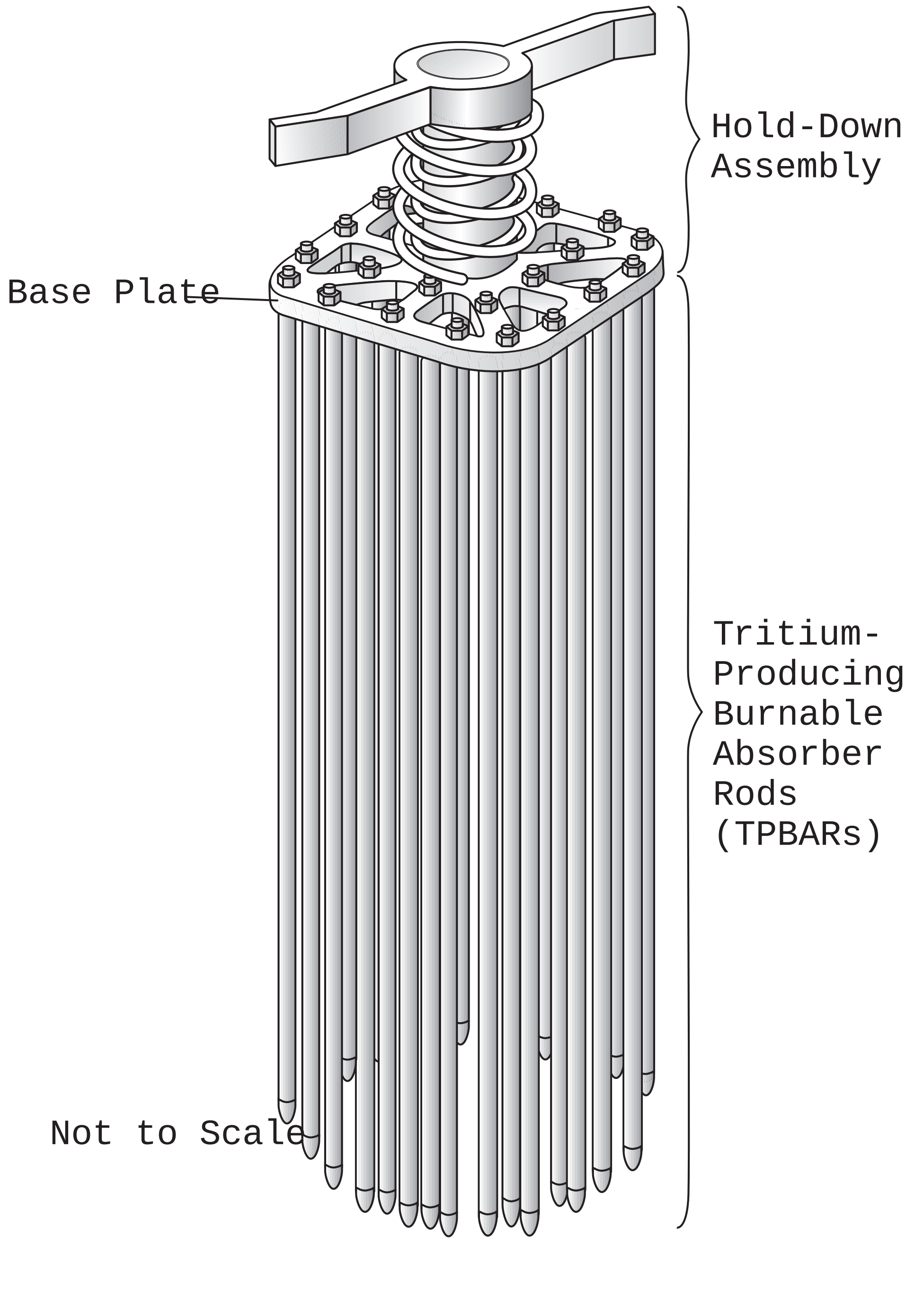


Figure S–4 Typical TPBAR Assembly

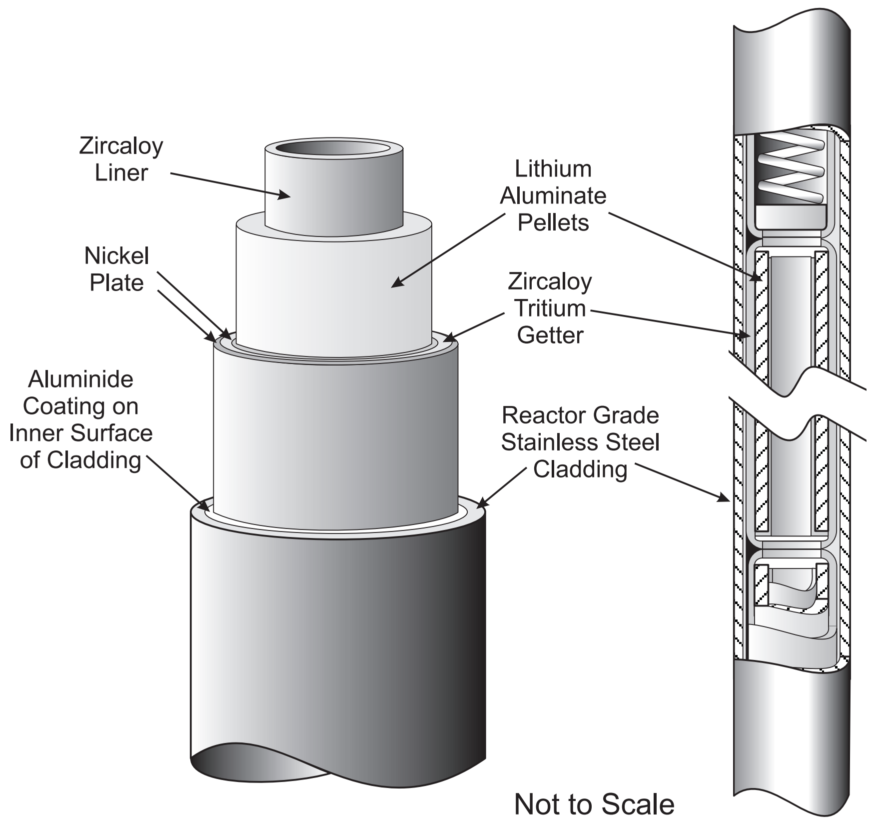


Figure S–5 Sketch of TPBAR Components

- Spent fuel—Additional spent fuel could be generated when a reactor operates in a tritium-producing mode. Depending on existing spent fuel capacity, additional storage for spent fuel could be required.

- Public and worker exposure—The increased levels of tritium in the reactor coolant and the additional activities required in the handling and processing of TPBARs would result in increased radiation exposure for the public, operations workers, and maintenance personnel.

- Transportation and handling—Irradiated TPBAR assemblies would be packaged and transported from the CLWR sites to the Savannah River Site for tritium extraction and purification. Some additional risks of an accident en route would be expected. In addition, low-level radioactive waste associated with the TPBARs would be packaged and transported for disposal at the Barnwell disposal facility or the Savannah River Site.

S.3.2 Development of Alternatives

S.3.2.1 Major Planning Assumptions and Basis for Analysis

The major planning assumptions and considerations that form the basis of the analyses and impact assessments presented in this EIS are listed below.

- The purpose of DOE's action is to produce tritium in a CLWR. Tritium is needed to maintain the nation's nuclear weapons stockpile. For the purposes of analysis in this EIS, DOE assumed that the CLWR program would be designed to produce up to 3 kilograms of tritium per year. Three kilograms of tritium represents an unclassified maximum requirement that only would be required if the tritium reserve, which is maintained for emergencies and contingencies, were ever lost or used (see Figure S–3). Considering the current design of the TPBARs and the efficiency of the tritium extraction process, this would involve the irradiation of up to 6,000 TPBARs in an 18-month refueling cycle (4,000 TPBARs per year). The maximum number of TPBARs that could be irradiated at each reactor unit without significantly disturbing the normal electricity-producing mode of reactor operation is approximately 3,400 TPBARs; the exact number depends on the specific design of the reactor. Steady-state tritium requirements, which are classified and would vary depending upon the specific requirements of the Nuclear Weapons Stockpile Plan, are less than 3 kilograms of tritium per year. This EIS evaluates the impacts at each reactor site by considering a range of 1,000 to 3,400 TPBARs. A sensitivity analysis of the irradiation of fewer than 1,000 TPBARs is included in Volume 1, Section 5.2.9 of the CLWR EIS.

  Producing 3 kilograms of tritium per year likely would be a short-term requirement to reconstitute the tritium reserve. In such a case, as explained in Appendix A of this EIS, it is technically feasible to produce larger quantities of tritium in a single reactor by changing some of the design parameters of the TPBARs and/or some technical parameters of the host reactor core, including shortening the refueling cycle. DOE does not foresee the implementation of this mode of production in any of the reactor units considered in this CLWR EIS. For the purpose of completeness, however, the sensitivity analysis in Volume 1, Section 5.2.9 of the CLWR EIS also addresses the environmental impacts of changing the existing design parameters of the TPBARs and some of the operating parameters of the host reactors to maximize tritium production.

- The EIS assesses the environmental impacts of tritium production in CLWRs for a period of 40 years, starting with the delivery of irradiated TPBARs at the Tritium Extraction Facility in approximately the year 2005. For alternatives involving the partially completed reactor(s), it is assumed that any construction activities needed for the completion of Bellefonte 1 (and any other start-up tests and activities) would take place during the time period between 1999 and 2004, at which time the completed reactor would be fully operational. In the event Bellefonte 2 was also selected for completion, Bellefonte 1 would come on line in approximately 2005, while Bellefonte 2 would begin operation in approximately 2007.

- CLWRs are licensed by NRC to operate for 40 years. Currently operating reactors are not in a position to continue operation beyond 40 years without NRC approval for "life extension." Some of the environmental impacts associated with life extension activities would be attributable to tritium production. The NRC has addressed the generic impacts of life extension in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. The life extension impacts associated with alternatives involving the currently operating units are based on this publication and are addressed generically in the EIS. Tritium production is not expected to affect relicensing. Life extension impacts for a partially completed reactor would not be an issue, since it would be expected to operate for 40 years after its completion.

- Tritium production in a currently operating reactor would not be expected to affect the radiological condition of the reactor at the end of its life. Therefore, environmental impacts associated with decommissioning and decontamination activities would be attributed to the normal operation of the reactor as an electricity-producing unit. For a partially completed reactor, the impacts from decommissioning and decontamination activities are evaluated in this EIS. Decommissioning and decontamination impacts are based on the generic EIS issued by the NRC entitled *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*.

- Fabrication of the TPBARs would take place in a commercial facility that normally fabricates and assembles the components for the fresh fuel used in the CLWRs.

- Production of tritium in a CLWR would increase the generation rate of spent fuel if more than approximately 2,000 TPBARs are irradiated in a fuel cycle. Normally (i.e., during normal operation with no tritium production), fuel assemblies are used in more than one cycle. However, in order to maximize tritium production, TPBARs would be inserted in fresh fuel assemblies. In accordance with the Nuclear Waste Policy Act of 1982, DOE is planning to manage all spent nuclear fuel at a national repository. Siting and development of a repository is ongoing, and the location and opening date for a suitable repository has not been determined. Accordingly, for the purposes of this EIS, the initial management of any additional spent nuclear fuel that may be generated as a result of tritium production is assumed to be stored on site in a generic dry cask independent spent fuel storage installation (ISFSI) pending the availability of a suitable repository. The environmental impacts from the construction and operation of an ISFSI are addressed in this EIS. However, no decision will be made to either construct or operate an ISFSI as a result of this EIS. Appropriate NEPA documentation would be prepared prior to the construction of a dry cask ISFSI.

S.3.2.2 Reasonable Alternatives

As discussed in Section S.1.4, DOE issued a Request for Proposals for the CLWR production of tritium. DOE stated in the Request for Proposals its intent to select one or both of two approaches: (1) the acquisition of CLWR irradiation services for tritium production, or (2) the purchase of an operating CLWR by DOE for production of tritium. The only qualified response to DOE's solicitation came from TVA, the operator of Watts Bar 1 and Sequoyah 1 and 2. TVA also maintains the partially completed units of Watts Bar 2 and Bellefonte 1 and 2. With the exception of Watts Bar 2, which was considered and dismissed, these units form the basis for the Reasonable Alternatives.

To <u>supply tritium to meet national security requirements,</u> DOE could use one or more reactors. Considering that a maximum number of 3,400 TPBARs could be irradiated in a single reactor, at least two reactors would be needed for the 6,000 TPBARs <u>based on an 18-month refueling cycle</u>. Considering also that additional spent nuclear fuel generation attributed to tritium production starts approximately with the irradiation of approximately 2,000 TPBARs in a single reactor, DOE could use as many as three reactors to irradiate 6,000 TPBARs without increasing the amount of spent nuclear fuel. Mathematically, DOE has the option of selecting 1 of the 18 combinations of reactor units presented in **Table S–1**. These 18 combinations form the Reasonable Alternatives of the irradiation element of the project.

S.3.2.3 No Action Alternative

On December 22, 1998, Energy Secretary Bill Richardson announced that CLWRs would be the primary tritium supply technology for tritium and that the accelerator would be developed—but not constructed as a backup to CLWR tritium production. Based on this announcement, if tritium is not produced in a CLWR, it will be produced in an accelerator. Accordingly, for purposes of analysis in this EIS, the No Action

Alternative assumes the continued operation of Watts Bar 1 and Sequoyah 1 and 2 for the generation of electricity and the deferral of construction activities necessary for completion of Bellefonte 1 and 2 as nuclear units. Consequently, this No Action alternative entails the production of tritium in an accelerator. A summary of the environmental impacts associated with the production of tritium in an accelerator is contained in Volume 1, Section 5.2.11 of the CLWR EIS. A comparison between the environmental impacts of the CLWR EIS reactor alternatives and those for accelerator production is presented in **Table S-3** at the end of this summary. Since the APT EIS was developed in parallel with the CLWR EIS, the impacts in Table S-3 represent the conclusions of the APT Draft EIS. These impacts are not expected to change in the APT Final EIS.

Table S–1 CLWR Tritium Production Program Reasonable Alternatives

Alternative	*Watts Bar 1 Operation*	*Sequoyah 1 Operation*	*Sequoyah 2 Operation*	*Bellefonte 1 Complete Construction and Operation*	*Bellefonte 2 Complete Construction and Operation*[a]
One Reactor[b]					
1	●				
2		●			
3			●		
4				●	
Two Reactor Combinations					
5	●	●			
6	●		●		
7	●			●	
8		●	●		
9		●		●	
10			●	●	
11				●	●
Three Reactor Combinations					
12	●	●	●		
13	●	●		●	
14	●		●	●	
15	●			●	●
16		●	●	●	
17		●		●	●
18			●	●	●

[a] Construction on Bellefonte 2 may be completed only if Bellefonte 1 is completed and operated.
[b] The one-reactor alternative could not produce 3 kilograms of tritium per year on an 18-month refueling cycle.

S.3.2.4 The Preferred Alternative

The Council on Environmental Quality regulations require that an agency identify its Preferred Alternative(s) in the Final EIS (40 CFR 1502.14e). The Preferred Alternative is defined as the alternative that the agency believes would fulfill its statutory mission, giving consideration to environmental, economic, technical, and other factors. This EIS provides information on the environmental impacts. Cost, schedule, and technical analyses will be discussed in the Record of Decision for the EIS. DOE has identified the purchase of irradiation services from the Watts Bar and Sequoyah reactor facilities as the Preferred Alternative for the production of tritium in a CLWR. Under the Preferred Alternative, no more than 3,400 TPBARs would be irradiated in a single reactor per each refueling cycle. In implementing the Preferred Alternative, DOE and TVA would minimize, to the extent practicable, the generation of additional spent nuclear fuel.

S.3.2.5 Reactor Options

S.3.2.5.1 Watts Bar Nuclear Plant Unit 1

Watts Bar 1 is located on a 716-hectare (1,770-acre) site in Rhea County, Tennessee, on the Tennessee River at Tennessee River Mile 528, approximately 80 kilometers (50 miles) northeast of Chattanooga, Tennessee. The general arrangement of the Watts Bar Nuclear Plant is shown in **Figure S–6**.

Watts Bar 1 began commercial power operation in May 1996. The Watts Bar 1 structures include a reactor containment building, a turbine building, an auxiliary building, a service building, a water pumping station for circulating water in the condenser, a diesel generator building, a river intake pumping station, a natural-draft cooling tower, a transformer yard, a 500-kilovolt switchyard and a 161-kilovolt switchyard, a spent nuclear fuel storage facility, and sewage treatment facilities. The reactor containment building houses a pressurized water reactor designed and manufactured by the Westinghouse Electric Corporation. No modifications are expected to be necessary for Watts Bar 1 to irradiate TPBARs. Design equipment and facilities are sufficient to load and unload the TPBAR assemblies. During normal operation with tritium production, the plant could employ a few more workers (less than 10) in addition to the 809 presently employed. The spent nuclear fuel storage capacity is not sufficient for 40 years of operation with or without TPBARs.

S.3.2.5.2 Sequoyah Nuclear Plant Units 1 and 2

Sequoyah 1 and 2 are operating, pressurized CLWR nuclear power plants. The units are located on a 212-hectare (525-acre) site in Hamilton County, Tennessee, on the Tennessee River at Tennessee River Mile 484.5, approximately 12 kilometers (7.5 miles) northeast of the nearest city limit of Chattanooga, Tennessee. The general arrangement of the Sequoyah Nuclear Plant is shown in **Figure S–7**.

Sequoyah 1 began commercial operation in July 1981, and Sequoyah 2 began commercial operation in June 1982. The nuclear steam supply systems, designed and manufactured by the Westinghouse Electric Corporation, include the reactor vessel, steam generators, and associated piping and pumps. These are housed in two reactor containment buildings. The balance of the nuclear power plant includes: a turbine building, an auxiliary building, a service and office building, a control building, a condenser circulating water pumping station, a diesel generator building, a river intake pumping station, two natural draft cooling towers, a transformer yard, a 500-kilovolt switchyard and a 161-kilovolt switchyard, spent nuclear fuel storage facilities, and sewage treatment facilities. No modifications are expected to be needed for Sequoyah 1 and 2 to irradiate TPBARs. Equipment and facilities are sufficient to load and unload the TPBAR assemblies. Tritium production could require the addition of a few more employees (fewer than 10 per unit) to the 1,120 employees currently employed at the two-unit site. The spent nuclear fuel storage capacity is not sufficient for 40 years of operation with or without TPBARs.

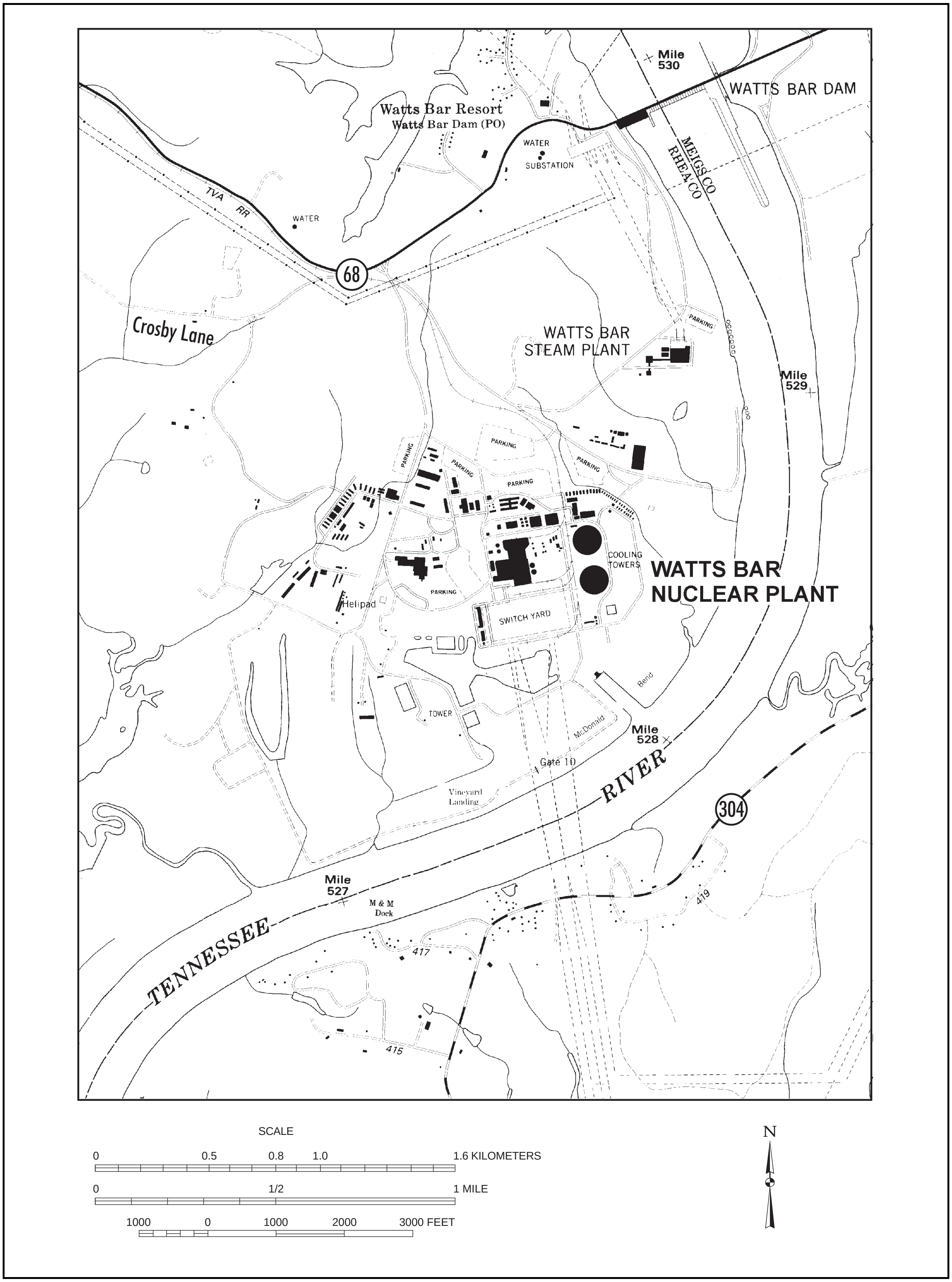


Figure S–6 Watts Bar Nuclear Plant

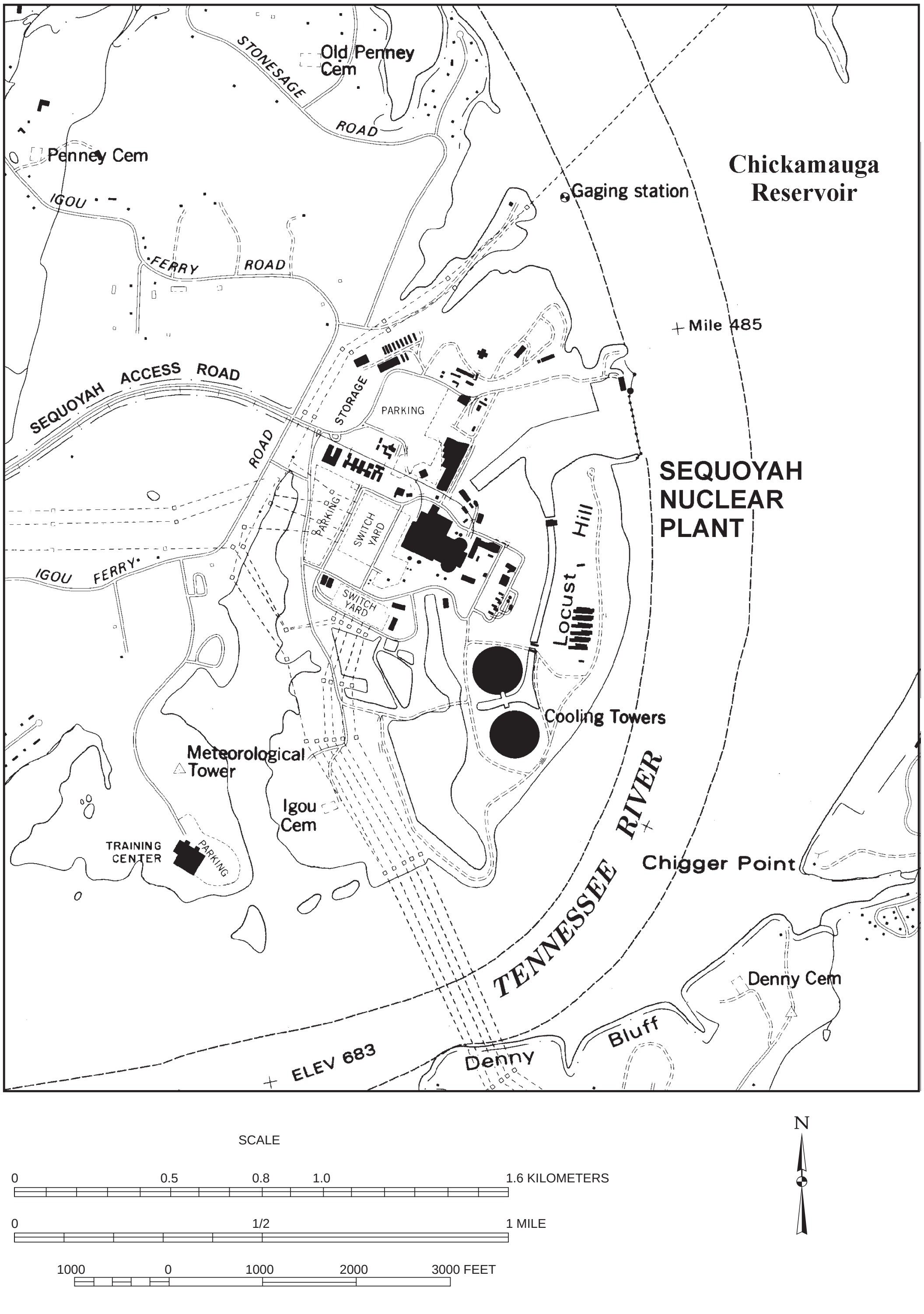


Figure S–7 Sequoyah Nuclear Plant

S.3.2.5.3 Bellefonte Nuclear Plant Units 1 and 2

Bellefonte 1 and 2 are partially completed reactors. They are situated on approximately 607 hectares (1,500 acres) on a peninsula at Tennessee River Mile 392, on the west shore of Guntersville Reservoir, about 11.3 kilometers (7 miles) northeast of Scottsboro, Alabama. The main land uses of the surrounding area are forestry and agriculture; however, urban-industrial development has grown over the past several years around the plant along the Guntersville Reservoir. The affected environment at the Bellefonte Nuclear Plant site is described in Section 4.2.3. The general arrangement of the Bellefonte Nuclear Plant is shown in **Figure S–8**.

The U.S. Atomic Energy Commission (now NRC) issued the construction permit for the Bellefonte Nuclear Plant in December 1974, and construction started in February 1975. On July 29, 1988, TVA notified NRC that Bellefonte was being deferred as a result of a lower load forecast for the near future. After three years of extensive study, TVA notified NRC on March 23, 1993, of its plans to complete Bellefonte 1 and 2. In December 1994, TVA announced that Bellefonte would not be completed as a nuclear plant without a partner and put further activities on hold until a comprehensive evaluation of TVA's power needs was completed. On April 29, 1996, TVA issued a Notice of Intent to prepare an EIS for the proposed conversion of the Bellefonte Nuclear Plant to a fossil fuel facility. The *Final Environmental Impact Statement for the Bellefonte Conversion Project*, which analyzed alternatives for such a conversion, was issued in October 1997. A Record of Decision for that EIS will not be made until it is determined whether Bellefonte 1 or both Bellefonte 1 and 2 will be used for tritium production.

The plant structures presently consist of two reactor containment buildings: a control building; a turbine building; an auxiliary building; a service building; a condenser circulating water pumping station; two diesel generator buildings; a river intake pumping station; two natural-draft cooling towers; a transformer yard; a 500-kilovolt switchyard and 161-kilovolt switchyard; a spent nuclear fuel storage pool; and sewage treatment facilities.

Additionally, there are office buildings to house engineering and other department personnel. Entrance roads, parking lots, railroad spurs, and a helicopter landing pad are in place and are capable of supporting a construction project.

No modifications to the original design would be necessary to complete Bellefonte 1 or Bellefonte 2 for operation, with or without TPBARs.

The plant systems and structures are maintained through active layup and preservation. Program activities include the following:

- Each unit's main turbine generators are rotated every other week.
- The diesel fire pumps are maintained in an operational status and are run monthly.
- The shell and tube sides of the main condensers (heat exchangers) are kept dry, and the tube side is maintained with a flow of warm, dehumidified air.
- The reactor coolant system is kept dry using a flow of warm, dehumidified air.

A workforce of approximately 80 personnel supports layup and preservation of the plant. Of that number, 38 are involved in operations and maintenance.

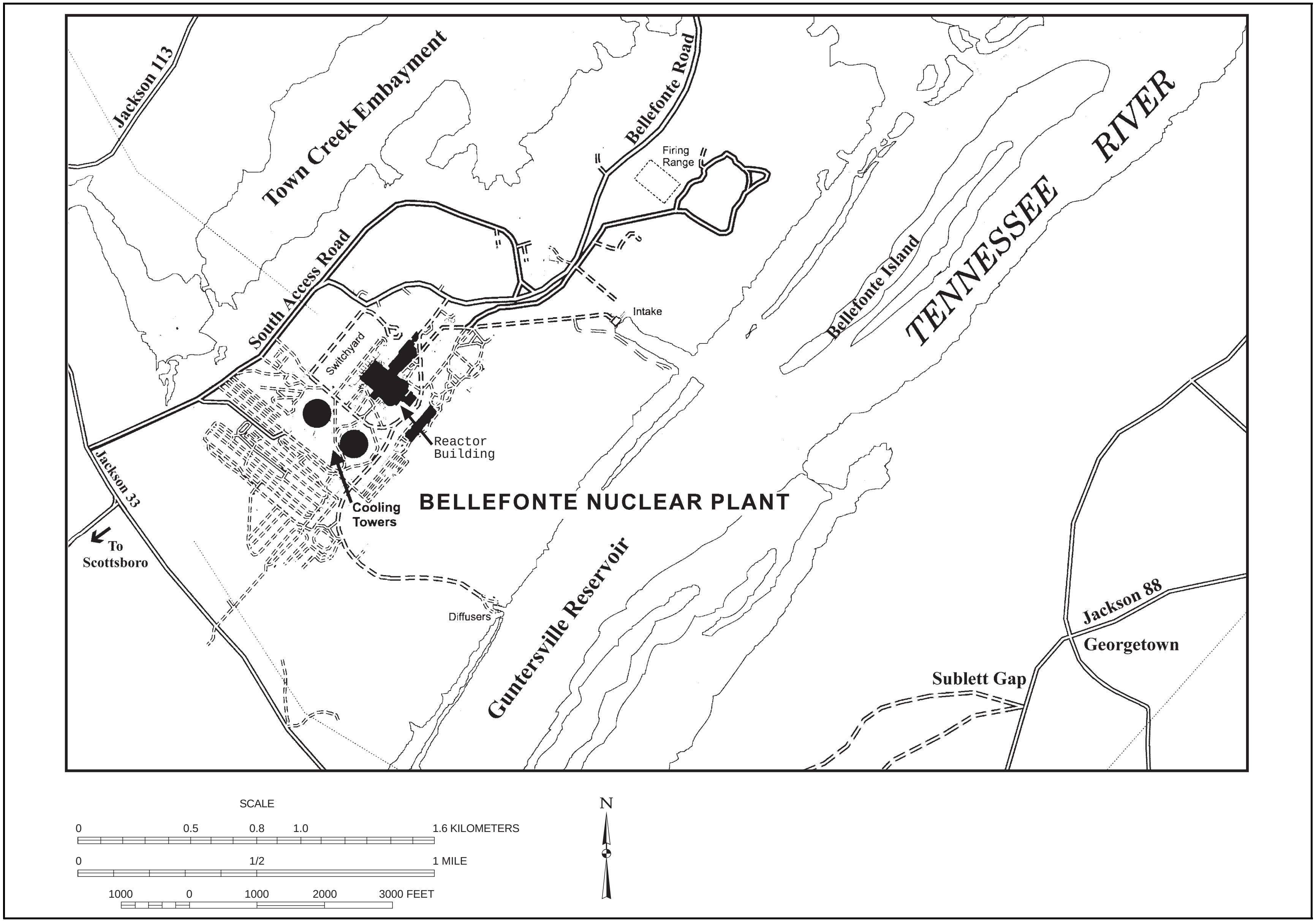


Figure S–8 Bellefonte Nuclear Plant

To complete Bellefonte 1 or both Bellefonte 1 and 2, additional engineering and construction activities would be required. These activities are summarized in the following paragraphs.

Engineering—Engineering for the original Bellefonte Nuclear Plant design is substantially complete. The additional engineering effort consists of completing analysis and design modifications that were not completed prior to deferral; updating the design basis documentation to current industry standards; and supporting construction, start up, and licensing of the plant. More specifically, the remaining engineering effort for Bellefonte 1 and 2 includes, but is not limited to, the following:

- Issuing detailed design modifications for certain mechanical and electrical systems to meet current requirements
- Updating the main control room drawings into computer-aided design electronic format
- Reviewing the control room design and upgrading the simulator and plant computers
- Reanalyzing piping and pipe supports
- Resolving industry issues (e.g., fire protection, electrical equipment qualification, station blackout, site security, communications, motor-operated valves) that were either not completed prior to deferral in 1988 or have arisen since deferral
- Developing fuel assembly and fuel cycle designs to facilitate the production of tritium
- Supporting submittals of the Final Safety Analysis Report and completing previous NRC position papers
- Supporting field change requests by the constructor

Construction—Construction activities required to complete Bellefonte 1 and 2 include, but are not limited to, the following:

- Completing the application of protective coatings to structures, piping, and components, and the installation of piping insulation
- Installing the Bellefonte 2 reactor coolant pump internals and motors [Some (less than 10 percent) of Bellefonte 1 reactor coolant instrumentation and pipe supports would have to be installed.]
- Installing limited major piping and components in the balance of the plant for Bellefonte 2
- Installing the steam piping for Bellefonte 2
- Installing and energizing a limited amount of the electric power equipment within the plant [The 161-kilovolt and 500-kilovolt offsite transmission lines are terminated in the switchyard, which is complete and energized.]
- Completing the Bellefonte 2 main control room [Substantial work would be required because the Bellefonte 1 main control room, although not complete, is functional and manned to monitor the ongoing preservation activities. The recommendations of the Control Room Design review would be factored into efforts to complete construction of both control rooms.]
- Preparing the intake structure for operation by desilting the intake water pump

- Constructing some new support buildings and installing additional equipment

S.3.2.6 Environmental Consequences

For the five TVA reactors being considered for tritium production (Watts Bar 1, Sequoyah 1, Sequoyah 2, Bellefonte 1, and Bellefonte 2), impacts are presented for the bounding case (i.e., the maximum number of TPBARs that could be irradiated in a reactor). For those resources where impacts would be significantly different for a lesser number of TPBARs, explanation is provided. The impacts of utilizing more than one CLWR for tritium production can be determined by adding the impacts of each individual CLWR together. The impacts of not producing tritium at any of these five reactors (the No Action Alternative) are presented first, as a baseline against which to compare the impacts of producing tritium. The summary of the environmental consequences is presented in **Table S-2** at the end of this summary.

S.3.2.6.1 No Action Alternative

Construction

Watts Bar 1 and Sequoyah 1 and 2. Under the No Action Alternative, Watts Bar 1 and Sequoyah 1 and 2 would continue to produce electricity, and no construction impacts would occur.

Bellefonte 1 and 2. Under the No Action Alternative, Bellefonte 1 and 2 would remain in deferred status, and no construction impacts would occur. TVA could also convert Bellefonte 1 and 2 to a fossil fuel plant, as described in the *Final Environmental Impact Statement for the Bellefonte Conversion Project* (see Volume 1, Section 1.5.2.4). Such conversion would be independent of this EIS and would not occur until a decision is made regarding the role of Bellefonte 1 and 2 in tritium production.

Operation

Watts Bar 1 and Sequoyah 1 and 2. Under the No Action Alternative, Watts Bar 1 and Sequoyah 1 and 2 would continue to produce electricity for the foreseeable future, and there would be no changes in the type and magnitude of environmental impacts that currently occur. In producing electricity, these reactor plants would continue to comply with all Federal, state, and local requirements. Impacts associated with the continued operation of Watts Bar 1 and Sequoyah 1 and 2 are described in the following paragraphs.

Under the No Action Alternative, water requirements at all three plants would continue to be met by existing water resources with no additional impacts, and water quality would not change, but would remain within regulatory limits. Air quality would also remain unchanged and stay within regulatory limits. Worker employment should remain steady at each of the sites, with no major changes to the regional economic areas as a result of plant operation. Worker exposure to radiation should remain well under the regulatory limit of 5 rem per year, with the average worker dose at approximately 90 to 100 millirems per year. Radiation exposure of the public from normal operations would also remain well within regulatory limits (3 rem per year) for each of the reactor sites. At Watts Bar 1, the total dose to the population within 80 kilometers (50 miles) would be approximately 0.55 person-rem per year. Statistically, this equates to one fatal cancer approximately every 3,570 years from operation of Watts Bar 1. At Sequoyah 1 or Sequoyah 2, the total dose to the population within 80 kilometers (50 miles) would be approximately 1.6 person-rem per year. Statistically, this equates to one fatal cancer approximately every 1,250 years from the operation of Sequoyah 1 or 2. Risks of accidents would remain unchanged.

Under the No Action Alternative, all categories of wastes would continue to be generated at each of the reactor plants, and they would be managed in accordance with regulations. Low-level radioactive wastes would continue to be generated at a rate of approximately 40 (Watts Bar 1) to 389 (Sequoyah 1 or Sequoyah 2) cubic meters per year and would be disposed of at the Barnwell disposal facility. For each of the reactors, spent fuel would also continue to be generated at a rate of approximately 80 fuel assemblies per year. Spent fuel would continue to be managed at each of the reactor plants in compliance with all regulatory requirements.

Bellefonte 1 and 2. Under the No Action Alternative, Bellefonte 1 and 2 would remain uncompleted nuclear reactors, and impacts on the environment would not change.

S.3.2.6.2 Impacts Associated with Tritium Production

Construction

Watts Bar 1 and Sequoyah 1 and 2. Because this EIS assumes that long-term spent fuel storage would take place at each of the reactor plants, an ISFSI could eventually be required for Watts Bar 1, Sequoyah 1, or Sequoyah 2 to support tritium production. This could be the only construction necessary for tritium production. If such a facility were to be constructed, it would consist of three reinforced concrete slabs covering approximately 3.5 acres. Approximately 60-80 horizontal storage modules, each made of reinforced concrete, could be housed on the slabs. These horizontal storage modules would have a hollow internal cavity to accommodate a stainless steel cylindrical cask that would contain the spent nuclear fuel. Constructing such a facility would disturb approximately 5 acres and require approximately 50 construction workers. Premixed concrete would be used, and impacts to air quality, water, and biotic resources are expected to be small. Appropriate NEPA documentation would be prepared prior to the construction of a dry cask spent fuel storage facility.

Bellefonte 1 and 2. All major structures (e.g., containment buildings, cooling towers, turbine buildings, support facilities) have been constructed, so construction activities would largely consist of internal modifications to the existing facilities. No additional land would be disturbed in completing construction, and there would be no impacts on visual resources, biotic resources (including threatened and endangered species), geology and soils, and archaeological and historic resources. Because this EIS assumes that long-term spent fuel storage would take place at each of the reactor plants, a dry cask spent fuel storage facility would eventually be required at Bellefonte 1 and 2. The impacts of constructing such a spent fuel storage facility would be similar to those described above for Watts Bar 1, Sequoyah 1, or Sequoyah 2. Appropriate NEPA documentation would be prepared before the construction.

Completing construction of Bellefonte 1 would have the greatest impact on socioeconomics, with construction activities taking place between 1999 and 2004. During the peak year of construction (2002), approximately 4,500 direct jobs could be created. As many as 4,500 secondary jobs (indirect jobs) would also be created. The total new jobs (9,000) would cause the regional economic area unemployment rate to decrease to approximately 4 percent from the current rate of 8.2 percent. Public finance expenditures/revenues would increase by over 30 percent in Scottsboro and about 15 percent in Jackson County. Rental vacancies would decline to near zero, and demand for all types of housing would increase substantially. Rents and housing prices could increase at double-digit percentage levels.

If Bellefonte 2 were also selected for completion, construction activities for both units would be drawn out, taking place between 1999 and 2005. The peak year of construction would shift, but the total number of direct and indirect jobs would be the same. The effects, therefore, on unemployment, public finance, rents, and housing prices would be the same as for the construction completion of Bellefonte 1.

Operation

Watts Bar 1 and Sequoyah 1 and 2. In a tritium production mode, these operating reactors would continue to comply with all Federal, state, and local requirements. Tritium production would have little or no effect on land use, visual resources, water use and quality, air quality, archaeological and historic resources, biotic resources (including threatened and endangered species), and socioeconomics. It could, however, have some incremental impacts in the following areas: radiation exposure (worker and public), spent fuel generation, and low-level radioactive waste generation. Tritium production could also change the accident and transportation risks associated with these reactors. Each of these areas is discussed below.

Radiation Exposure Tritium production could increase average annual worker radiation exposure by approximately 0.82–1.1 millirem per year. The resultant dose would be well within regulatory limits. Radiation exposure to the public from normal operations could also increase, but would still remain well within regulatory limits at each of the reactor sites. At either Watts Bar 1, Sequoyah 1, or Sequoyah 2, the total dose to the population within 80 kilometers (50 miles) could increase by a maximum of 1.9 person-rem per year. Statistically, this equates to one additional fatal cancer approximately every 1,000 years from the operation of Watts Bar 1, Sequoyah 1, or Sequoyah 2.

Spent Fuel Generation Given irradiation of 3,400 TPBARs (the maximum number of TPBARs without changing the reactor's fuel cycle), additional spent fuel would be generated at Watts Bar 1, Sequoyah 1, or Sequoyah 2. In the average 18-month fuel cycle, spent fuel generation could increase from approximately 80 spent fuel assemblies up to a maximum of 140, a 71

Health Effects Risk Factors Used in this EIS

Health impacts of radiation exposure, whether from sources external or internal to the body, are generally identified as "somatic" (i.e., affecting the exposed individual), or "genetic" (i.e., affecting descendants of the exposed individual). Radiation is more likely to produce somatic effects than genetic effects. Except for leukemia, which can have an induction period (time between exposure to carcinogen and cancer diagnosis) of as little as 2 to 7 years, most cancers have an induction period of more than 20 years.

For a uniform irradiation of the body, the incidence of cancer varies among organs and tissues; the thyroid and skin demonstrate a greater sensitivity than other organs. Such cancers, however, also produce comparatively low mortality rates because they are relatively amenable to medical treatment. Because of the readily available data for cancer mortality rates, somatic effects leading to cancer fatalities, rather than cancer incidence, are presented in this EIS. The numbers of cancer fatalities can be used to compare the risks of various alternatives.

Risk factors are used to calculate the statistical expectance of the effects of exposing a population to radiation. For example, in a population of 100,000 people exposed only to natural background radiation (300 millirem per year), about 15 latent cancer fatalities per year would be expected (100,000 persons x 0.3 rem per year x 0.0005 latent cancer fatalities per person-rem = 15 latent cancer fatalities per year).

The number of latent cancer fatalities corresponding to a single individual's exposure over a presumed 72-year lifetime to 0.3 rem per year is 0.011 (1 person x 0.3 rem per year x 72 years x 0.0005 latent cancer fatality per person-rem = 0.011 latent cancer fatality). Presented another way, this method estimates that approximately 1.1 percent of the population might die of cancers induced by background radiation. The same calculations apply to workers with one difference; the risk factor for workers is 0.004 latent cancer fatalities per person-rem instead of 0.005 cancer fatalities per person-rem for the general public.

The health consequences of exposure to radionuclides from normal operation and accidents are converted to estimates of cancer fatality risks using dose conversion factors recommended by the International Commission on Radiological Protection. For individuals, the estimated probability of a latent cancer fatality occurring is reported for the noninvolved worker, the maximally exposed individual, and an average individual in the general population. These categories are defined as follows:

Noninvolved Worker: *An individual 640 meters (0.4 mile) from the radioactive material release point.*

Maximally Exposed Offsite Individual: *A hypothetical individual who could potentially receive the maximum dose of radiation or hazardous chemicals.*

General Population: *Individuals within an 80-kilometer (50-mile) radius of the facility.*

percent increase in spent fuel generation over the No Action Alternative. Because this EIS assumes that long-term spent fuel storage would take place at each of the reactor plants, a dry cask spent fuel storage facility would eventually be needed. Storing the additional spent fuel should have minor impacts. Radiation exposures would remain below regulatory limits for both workers and the public, and less than 4 cubic feet of low-level radioactive waste would be generated annually. The impacts of accidents associated with dry cask spent fuel storage would be small. As previously mentioned, appropriate NEPA documentation would be prepared before the construction of a dry cask spent fuel storage facility at Watts Bar 1, Sequoyah 1, or Sequoyah 2. If fewer than approximately 2,000 TPBARs were irradiated, there would be no change in the amount of spent fuel produced by the reactors.

Spent Fuel Storage

The need for additional spent fuel storage is based on the assumption that 3,400 TPBARs would be irradiated in a reactor core for 18-month fuel cycles. However, if approximately 2,000 TPBARs or fewer were irradiated in each fuel cycle, no additional spent fuel would be generated.

The additional spent fuel generated from the tritium production over the duration of the program, would be accommodated at the site at an independent dry cask spent fuel storage installation (ISFSI). The EIS presents the environmental impacts of the construction, operation, and postulated accidents associated with a generic dry cask ISFSI at each of the sites.

The majority of operating ISFSIs are in the form of concrete casks. Concrete casks consist of either a vertical or horizontal concrete structure that houses a metal cask that confines the spent nuclear fuel. A horizontal storage module consists of a rectangular reinforced concrete block that has a hollow internal cavity to accommodate a stainless steel cylindrical cask that contains the spent nuclear fuel. The concrete block is 5.79 meters (19 feet) long, 2.96 meters (9.7 feet) wide, and 4.6 meters (15 feet) high.

The decay heat released from the stored spent fuel would be equal to the heat released to the atmosphere from two to six average cars. NRC regulations require that a minimum distance of 100 meters (328 feet) be maintained as a controlled area around the spent fuel casks. At 100 meters, the direct-scattered total dose rate to an individual was calculated to be in the range of 0.01 to 0.1 mrem/hr.

The environmental consequences of the construction and operation of a generic dry cask storage facility are minor.

<u>Low-Level Radioactive Waste Generation</u> Compared to the No Action Alternative, tritium production at Watts Bar 1, Sequoyah 1, or Sequoyah 2 would generate approximately 0.43 additional cubic meter per year of low-level radioactive waste. This would be a 0.1 (Sequoyah 1 or Sequoyah 2) to 1.0 (Watts Bar 1) percent increase in low-level radioactive waste generation over the No Action Alternative. Such an increase would amount to less than 1 percent of the low-level radioactive waste disposed of at the Barnwell disposal facility. The EIS also analyzes the impacts of this low-level radioactive waste disposal at the Savannah River Site. Disposing of 0.43 cubic meter per year of low-level radioactive waste would amount to less than 1 percent of the low-level radioactive waste disposed of at the Savannah River Site and less than 1 percent of the landfill's capacity.

<u>Accident Risks</u> Tritium production could change the potential risks associated with accidents at Watts Bar 1, Sequoyah 1, or Sequoyah 2. As described in the following text, these changes would be small. Potential impacts from accidents were determined using computer modeling. If a limiting design-basis accident occurred, tritium production at the 3,400 TPBAR level would increase the individual risk of a fatal cancer by $\underline{1.4 \times 10^{-9}}$ to an individual living within 80 kilometers (50 miles) of Watts Bar 1. Statistically, this equates to a risk to the individual of one fatal cancer approximately every <u>710</u> million years from tritium production. For an individual living within 80 kilometers (50 miles) of Sequoyah 1 or Sequoyah 2, there would be a $\underline{2.1 \times 10^{-9}}$ increased likelihood of a cancer fatality to an individual from a design-basis accident as a result of tritium production. Statistically, this equates to a risk to an individual of one additional fatal cancer approximately every <u>490</u> million years from tritium production. For a beyond design-basis accident (an accident that has a

probability of occurring approximately once in a million years or less), tritium production would result in small changes in the consequences of an accident. This is due to the fact that the potential consequences of such an accident would be dominated by radionuclides other than tritium.

Transportation Tritium production at either Watts Bar 1, Sequoyah 1, or Sequoyah 2 would necessitate additional transportation to and from the reactor plants. Most of the additional transportation would involve nonradiological materials. Impacts would be limited to toxic vehicle emissions and traffic fatalities. At each of these reactors, the transportation risks would be less than one fatality per year. Radiological materials transportation impacts would include routine and accidental doses of radioactivity. The risks associated with radiological materials transportation would be less than one fatality per 100,000 years.

Bellefonte 1 and 2. Because neither Bellefonte 1 or Bellefonte 2 are currently operating, this EIS assesses the impacts of completing construction and operating these units for tritium production. Consequently, environmental impacts would occur in the following resources: visual resources, water use, biotic resources, socioeconomics, radiation exposure (worker and public), spent fuel generation, and low-level radioactive waste generation. Tritium production would also change the accident and transportation risks associated with these reactors.

During operations, Bellefonte 1 and 2 would produce vapor plumes from cooling towers that would be visible up to 10 miles away. These plumes could create an aesthetic impact on the towns of Pisgah, Hollywood, and Scottsboro, Alabama.

During operation, Bellefonte 1 and 2 each would use less than 0.5 percent of the river flow from Guntersville Reservoir and would not have any adverse impacts on other users. Discharges from the plants would be treated and monitored before release and would comply with NPDES permits. Impacts on water quality would be minimal, and no standards would be exceeded as a result of Bellefonte operations. Operation of either Bellefonte 1 or both Bellefonte 1 and 2 for tritium production would have some effects on ecological resources typical to the operation of a nuclear power plant, regardless of tritium production. Impacts on ecological resources from the operation of Bellefonte 1 or both Bellefonte 1 and 2

Transportation

DOE takes many precautions to ensure the safe transportation of both its radioactive and nonradioactive shipments. These precautions satisfy U.S. Department of Transportation Regulations, NRC regulations, and DOE Orders. DOE would use Type A packages to transport materials with relatively low levels of radioactivity and Type B packages to transport materials with the highest levels of radioactivity. Type A packages are designed and tested to protect and retain their content under normal transportation conditions. They are tested to survive water spray, dropping during handling, compression by other packages, and penetration by falling objects. Type B packages are designed to protect and retain their contents in both normal and severe accident conditions. In addition, the U.S. Department of Transportation has stringent routing requirements for these shipments. These requirements include reducing the time in transit and the distance traveled, using interstate highways unless the state has designated a preferred alternative, and using beltways around cities where possible. The following are a few of the key safety measures the CLWR project will take to ensure safe shipment.

- *The fuel assemblies with the inserted TPBARs (or the TPBARs themselves) would be transported to the selected reactor(s) according to the fuel manufacturer's current operating practices. The nuclear containers used for fresh fuel shipment would be NRC-certified Type A packages and due to security requirements would have an escort.*
- *The transportation of irradiated TPBARs entails very stringent safety measures established by the NRC, the U.S. Department of Transportation, and DOE. TPBARs would be transported from the reactors to DOE's Savannah River Site in Type B packages that meet the NRC's stringent test requirements.*
- *Low-level radioactive waste would be transported in either certified Type A or Type B packages, depending on the level of the radioactivity of the contents.*

would result from radioactive and nonradioactive emissions of air pollutants to the atmosphere; thermal, chemical and radioactive effluent releases to surface waters; increases in human activity; and increases in noise levels. These impacts would be small considering that the units would operate in compliance with all Federal, state, and local requirements specifically promulgated to protect environmental resources. The estimated radiological doses to terrestrial and aquatic organisms are well below levels that could have any impact on plants or terrestrial and aquatic animals at the site. Other possible environmental impacts on the aquatic ecosystem of Guntersville Reservoir due to operation of the Bellefonte units would include fish losses at the cooling water intake screens, almost total loss of unscreened entrained organisms, and effects of thermal and chemical discharges. The effects of both thermal and chemical discharges would be small, as these discharges would comply with NPDES limitations.

Socioeconomics During operations, approximately 800 direct jobs would be created at Bellefonte 1, along with approximately an equal number of indirect jobs. The total new jobs (approximately 1,600) would cause the regional economic area unemployment rate to decrease to approximately 6.2 percent. Public finance expenditures/revenues would decline from the levels achieved during construction, but would remain 10 to 15 percent higher than they would be otherwise at Scottsboro and 5 to 10 percent higher in Jackson county. Housing prices would decline and could fall below the precompletion prices, depending on how much new construction of permanent housing took place during the completion period and how many construction workers chose to remain in the area once construction was completed. If Bellefonte 2 were also completed, a total of approximately 1,000 direct jobs would be created along with approximately 1,000 indirect jobs.

Radiation Exposure Reactor operations to produce tritium would cause worker radiation exposure to increase from 0 to approximately 105 millirem per year. This resultant dose would be well within regulatory limits of 5,000 millirem per year. Radiation exposure to the maximally exposed individual from normal operations would increase from 0 to 0.28 millirem. The total dose to the population within 80 kilometers (50 miles) would increase from approximately 0 to

Accident Scenarios

The accident analysis assessment considers a spectrum of potential accident scenarios. The range of accidents considered includes reactor design basis accidents, nonreactor design basis accidents, TPBAR-handling accidents, transportation cask-handling accidents, and beyond design basis accidents (i.e., severe reactor accidents).

***Reactor Design basis Accident**: A reactor design basis accident is designated a Condition IV occurrence. Condition IV occurrences are faults that are not expected to take place, but are postulated because they have the potential to release significant amounts of radioactive material. The postulated reactor design basis accident for this EIS is a large-break loss-of-coolant accident.*

***Nonreactor Design basis Accident**: A nonreactor design basis accident is designated a Condition III occurrence. The consequences of a Condition III occurrence would be less severe than those of a Condition IV occurrence. The release of radioactivity would not be sufficient to interrupt or restrict public use of those areas beyond the exclusion area. The postulated nonreactor design basis accident is an unexpected, uncontrolled release of the gases contained in a single gas decay tank due to the failure of the tank or associated piping.*

***TPBAR–Handling Accident**: The postulated TPBAR-handling accident scenario postulated that a TPBAR assembly containing 24 TPBARs was dropped when removing the assembly from an irradiated fuel assembly during the TPBAR consolidation process. The evaluation postulated that all TPBARs would be unprotected and would breach when they impacted the spent fuel pool floor.*

***Transportation Cask–Handling Accident**: Scenarios include loading a truck cask under water in the spent fuel pool cask loading pit with a single TPBAR consolidation container containing a maximum of 289 TPBARs, and loading a rail cask under water in the spent fuel pool cask loading pit with 3 to 12 TPBAR consolidation containers.*

***Beyond Design Basis Accident**: The beyond design basis accident is limited to severe reactor accidents. Severe reactor accidents are less likely than reactor design basis accidents; however, the consequences of these accidents could be more serious if no mitigative actions were taken. In the reactor design basis accidents, the mitigative systems are assumed to be available. The beyond design basis accidents analyzed are reactor core disruptive accidents with containment failure or bypass.*

approximately 2.3 person-rem per year for Bellefonte 1. If Bellefonte 2 were also operating, this dose would be approximately 4.6 person-rem per year. Statistically, this equates to one fatal cancer approximately every 435 years from the operation of Bellefonte 1 and 2.

Spent Fuel Generation Given production of the maximum amount of tritium in the average 18-month fuel cycle, spent fuel generation would increase from 0 up to a maximum of 141 spent fuel assemblies (i.e., 69 fuel assemblies over the normal refueling size). Because this EIS assumes that long-term spent fuel storage would take place at each of the reactor plants, a dry cask spent fuel storage facility could eventually be needed to store the additional assemblies. The impacts of storing the spent fuel in a dry cask spent fuel storage facility are described above for the existing operating reactor plants. As previously mentioned, appropriate NEPA documentation would be prepared before the construction of a dry cask spent fuel storage facility.

Low-Level Radioactive Waste Generation Compared to the No Action Alternative, reactor operation to produce tritium at Bellefonte 1 or Bellefonte 2 would generate approximately 40 cubic meters (80 cubic meters for both units) of low-level radioactive waste. This quantity would be a small fraction of the landfill capacity at the Barnwell disposal facility or the Savannah River Site's low-level radioactive waste disposal facility.

Accident Risks Compared to the No Action Alternative, there is a significant change in potential risks from tritium production. Risks due to accidents would increase during the construction and operation of Bellefonte 1 and 2, and during the operation of these units for production of tritium. Similar to Watts Bar 1 and Sequoyah 1 and 2, the potential impacts from the accidents at Bellefonte 1 or Bellefonte 2 were determined using computer modeling. If a limiting design-basis accident occurred, tritium production would increase the individual risk of a fatal cancer by 8.0×10^{-10} additional fatal cancers to an individual living within 80 kilometers (50 miles) of the units. Statistically this means that, for one individual, one fatal cancer would occur approximately every 1.3 billion years from tritium production at Bellefonte. If a beyond design-basis accident occurred (an accident that has a probability of occurring approximately once in a million years or less), tritium production would increase the risk of a fatal cancer by 0.00010 additional fatal cancers to an individual living within 80 kilometers (50 miles) of the Bellefonte Nuclear Plant.

Transportation Tritium production at either Bellefonte 1 or 2 would necessitate transportation of workers, construction material, and radiological and nonradiological material to and from the reactor plants. Most of the additional transportation would involve nonradiological materials. Impacts of this transportation are limited to toxic vehicle emissions and traffic fatalities. For Bellefonte 1 or 2, the transportation risks would be significantly lower than one fatality per year. Radiological materials transportation impacts would occur as a result of routine and accidental doses. In all instances the risks associated with radiological materials transportation would be less than one fatality per 100,000 years.

Table S-2 Summary of Environmental Consequences for the CLWR Reactor Alternatives

Resource/Material Categories	*Watts Bar 1*	*Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 2*
		No Action	
All Resource/Material Categories	No construction or operational changes. Reactor unit continues to produce electricity. No change in environmental impacts.	No construction or operational changes. Reactor units continue to produce electricity. No change in environmental impacts.	No construction or operational changes. Reactor units remain uncompleted. No change in environmental impacts.
		Annual Tritium Production	
Land Resources Land Use	*Construction:* Potential land disturbance - 5.3 acres for dry cask ISFSI if constructed. *Operation:* Potential permanent land requirement - 3.1 acres for an ISFSI if constructed.	*Construction:* Potential land disturbance - 5.47 acres for ISFSI if constructed. *Operation:* Potential permanent land requirement - 3.2 acres for an ISFSI if constructed.	*Construction:* Potential land disturbance - 4.9 acres for ISFSI if constructed and additional land for support buildings. *Operation:* Potential permanent land requirement - 3.4 acres for an ISFSI if constructed and additional land for support buildings.
Visual Resources	*Construction and Operation:* No additional impact to visual resources.	*Construction and Operation:* No additional impact to visual resources.	*Construction:* No additional impact to visual resources. *Operation:* Cooling tower vapor plumes would be visible up to 10 miles away.
Noise	*Construction:* No change from current levels. Small impacts if an ISFSI is constructed. *Operation:* No change from current levels.	*Construction:* No change from current levels. Small impacts if an ISFSI is constructed. *Operation:* No change from current levels.	*Construction:* No change from current levels except for construction vehicle traffic. Small impacts if an ISFSI is constructed. *Operation:* Increase in noise levels from 50 dBA (decibels A-weighted) to 51 dBA at nearest receptor. Increase in traffic noise onsite access roads from 50 dBA to 57 dBA due to commuter traffic and truck deliveries.

Resource/Material Categories	*Watts Bar 1*	*Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 2*
Air Quality Nonradioactive Emissions	*Construction:* No change from current air quality conditions. Small impacts if ISFSI is constructed. *Operation:* No change from current air quality conditions.	*Construction:* No change from current air quality conditions. Small impacts if ISFSI is constructed. *Operation:* No change from current air quality conditions.	*Construction:* Potential temporary dust emissions during construction. Small impacts if ISFSI is constructed. *Operation:* The increase in nonradioactive air pollutant concentrations would be well within established standards.
Air Quality Radioactive Emissions	*Construction:* No radioactive emissions. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 100 Curies; given 3,400 TPBARs, 340 Curies.	*Construction:* No radioactive emissions. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 100 Curies; given 3,400 TPBARs, 340 Curies.	*Construction:* No radioactive emissions. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 106 Curies; given 3,400 TPBARs, 346 Curies, of which 5.6 Curies would be from normal operation without tritium production. The release of other radioactive emissions would be 283 Curies.
Water Resources Surface Water	*Construction:* No change to current surface water requirements, discharge, or water quality conditions. Small impacts if ISFSI is constructed. *Operation:* No change to current surface water requirements, discharge, or water quality conditions.	*Construction:* No change to current surface water requirements, discharge, or water quality conditions. Small impacts if ISFSI is constructed. *Operation:* No change to current surface water requirements, discharge, or water quality conditions.	*Construction:* Potential for increased storm water runoff. Small amount of surface water requirements. Small impacts if ISFSI is constructed. *Operation:* Increased surface water requirements and discharge. Water usage less than 1 percent of Tennessee River flow per year. All water quality parameters within established limits.
Radioactive Effluent	*Construction:* No radioactive effluents. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive tritium effluents would be 900 Curies; given 3,400 TPBARs, 3,060 Curies.	*Construction:* No radioactive effluents. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive tritium effluents would be 900 Curies; given 3,400 TPBARs, 3,060 Curies.	*Construction:* No radioactive effluents. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive tritium effluents would be 1,539 Curies; given 3,400 TPBARs, 3,699 Curies, of which 639 Curies would be from normal operation without tritium production. The release of other radioactive effluents would be 1.32 Curies.

Resource/Material Categories	*Watts Bar 1*	*Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 2*
Groundwater	*Construction:* No groundwater requirements or additional impacts to groundwater quality conditions. *Operation:* No groundwater requirements or additional impacts to groundwater quality conditions.	*Construction:* No groundwater requirements or additional impacts to groundwater quality conditions. *Operation:* No groundwater requirements or additional impacts to groundwater quality conditions.	*Construction:* Groundwater would not be used during construction. *Operation:* No groundwater requirements or additional impacts to groundwater quality conditions.
Ecological Resources	*Construction*: No additional impacts on ecological resources. Small impacts if ISFSI is constructed. *Operation*: Small or no impacts to ecological resources from additional tritium releases.	*Construction*: No additional impacts on ecological resources. Small impacts if ISFSI is constructed. *Operation*: Small or no impacts to ecological resources from additional tritium release.	*Construction:* Potential impacts to ecological resources due to the small amount of land disturbance. Small impacts if ISFSI is constructed. *Operation:* Additional impacts on ecological resources including fish impingement and entrainment of aquatic biota during normal plant operation. Small impacts to ecological resources from tritium and other radioactive releases during normal plant operations.
Socioeconomics	*Construction:* No measurable impact. *Operation:* <1 percent impact on regional economy.	*Construction:* No measurable impact. *Operation:* <1 percent impact on regional economy.	*Construction:* 4,500 peak new direct jobs due to plant completion. Short-term increased costs and traffic for local jurisdictions. *Operation:* 800 to 1,000 workers per day. Increase in payment-in-lieu of taxes to state and local jurisdictions (approximately $5.5 to $8 million annually), decrease in the unemployment rate (from 8.2 percent to approximately 6.2 percent), and minor impacts to school resources.

Resource/Material Categories	*Watts Bar 1*	*Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 2*
Public and Occupational Health and Safety Normal Operation	Annual dose for 1,000 TPBARs: *Workers:* Average dose increase by 0.33 millirem. *Maximally Exposed Individual:* Dose increase by 0.013 millirem. *50-mile population:* Dose increase by 0.34 person-rem. Annual dose for 3,400 TPBARs: *Workers:* Average dose increase by 1.1 millirem. *Maximally Exposed Individual:* Dose increase by 0.05 millirem *50-mile population:* Dose increase by 1.3 person-rem.	Annual dose for 1,000 TPBARs: *Workers:* Average dose increase by 0.24 millirem. *Maximally Exposed Individual:* Dose increase by 0.017 millirem. *50-mile population:* Dose increase by 0.60 person-rem. Annual dose for 3,400 TPBARs: *Workers:* Average dose increase by 0.82 millirem. *Maximally Exposed Individual:* Dose increase by 0.057 millirem *50-mile population:* Dose increase by 1.9 person-rem.	Annual dose for 1,000 TPBARs: *Workers:* Average dose increase by 104.33 millirem, of which 104 millirem would be from normal operations without tritium production. *Maximally Exposed Individual:* Dose increase by 0.263 millirem, of which 0.26 millirem would be from normal operations without tritium production. *50-mile population:* Dose increase by 1.6 person-rem, of which 1.4 person-rem would be from normal operations without tritium production. Annual dose for 3,400 TPBARs: *Workers:* Average dose increase by 105.1 millirem, of which 104 millirem would be from normal operations without tritium production. *Maximally Exposed Individual:* Dose increase by 0.28 millirem. *50-mile population:* Dose increase by 2.3 person-rem.
Design-Basis Accident Risks	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual:* 3.4×10^{-8} (1 fatality in 29 million years). *Average individual in population:* 4.0×0^{-10} (1 fatality in 2.5 billion years). *Exposed population*: 0.000074 (1 fatality in 13 thousand years). *Noninvolved worker:* $4.2\text{x}10^{-10}$ (1 fatality in 2.4 billion years).	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual :* 7.9×10^{-9} (1 fatality in 130 million years). *Average individual in population:* 6.1×10^{-10} (1 fatality in 1.6 billion years). *Exposed population*: 0.00015 (1 fatality in 6.6 thousand years). *Noninvolved worker:* $1.3\text{x}10^{-10}$ (1 fatality in 7.7 billion years).	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual:* 3.5×10^{-7} (1 fatality in 2.9 million years). *Average individual in population:* 2.6×10^{-10} (1 fatality in 3.8 billion years). *Exposed population*: 0.000070 (1 fatality in 14 thousand years). *Noninvolved worker:* $1.2\text{x}10^{-12}$ (1 fatality in 83 billion years).

Resource/Material Categories	***Watts Bar 1***	***Sequoyah 1 or Sequoyah 2***	***Bellefonte 1 or Bellefonte 2***
	Involved worker, reactor design-basis accident: In the highly unlikely event that workers are in containment at the time of the accident they will die due to the energy (steam) released to the containment. Evacuation from containment is not considered feasible. *Involved worker, nonreactor design-basis accident:* In the highly unlikely event that involved workers are in the immediate area of a rupture of the waste gas decay tank or associated piping, they could be injured by debris or the stream of gas from the rupture. In addition, involved workers could receive a radiation dose while evacuating the area. If the accident is initiated by a valve failure or human error, the release will be vented out of the auxiliary building stack. The involved worker is not at risk of injury or an additional radiation dose.	*Involved worker, reactor design-basis accident:* In the highly unlikely event that workers are in containment at the time of the accident they will die due to the energy (steam) released to the containment. Evacuation from containment is not considered feasible. *Involved worker, nonreactor design-basis accident:* In the highly unlikely event that involved workers are in the immediate area of a rupture of the waste gas decay tank or associated piping, they could be injured by debris or the stream of gas from the rupture. In addition, involved workers could receive a radiation dose while evacuating the area. If the accident is initiated by a valve failure or human error, the release will be vented out of the auxiliary building stack. The involved worker is not at risk of injury or an additional radiation dose.	*Involved worker, reactor design-basis accident:* In the highly unlikely event that workers are in containment at the time of the accident they will die due to the energy (steam) released to the containment. Evacuation from containment is not considered feasible. *Involved worker, nonreactor design-basis accident:* In the highly unlikely event that involved workers are in the immediate area of a rupture of the waste gas decay tank or associated piping, they could be injured by debris or the stream of gas from the rupture. In addition, involved workers could receive a radiation dose while evacuating the area. If the accident is initiated by a valve failure or human error, the release will be vented out of the auxiliary building stack. The involved worker is not at risk of injury or an additional radiation dose.
	For 3,400 TPBARs: *Maximally Exposed Individual:* 1.1×10^{-7} (1 fatality in 9.1 million years). *Average individual in population:* 1.4×10^{-9} (1 fatality in 710 million years). *Exposed population*: 0.00026 (1 fatality in 3.8 thousand years). *Noninvolved worker:* $1.5\text{x}10^{-9}$ (1 fatality in 670 million years). *Involved worker:* Same as for 1,000 TPBARs.	For 3,400 TPBARs: *Maximally Exposed Individual :* 2.7×10^{-8} (1 fatality in 37 million years). *Average individual in population:* 2.1×10^{-9} (1 fatality in 480 million years). *Exposed population*: 0.00052 (1 fatality in 1.9 thousand years). *Noninvolved worker:* $4.5\text{x}10^{-10}$ (1 fatality in 2.2 billion years). *Involved worker:* Same as for 1,000 TPBARs.	For 3,400 TPBARs: *Maximally Exposed Individual:* 3.6×10^{-7} (1 fatality in 2.8 million years). *Average individual in population:* 8.0×10^{-10} (1 fatality in 1.3 billion years). *Exposed population*: 0.00022 (1 fatality in 4.6 thousand years). *Noninvolved worker:* $4.3\text{x}10^{-12}$ (1 fatality in 230 billion years). *Involved worker:* Same as for 1,000 TPBARs.

Resource/Material Categories	*Watts Bar 1*	*Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 2*
Beyond Design-Basis Accident Risks	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual:* Due to accuracy limitations in the accident analysis computer code, the incremental risk of tritium production is not discernable from the risk of operation without tritium production. *Average individual in population:* Due to accuracy limitations in the accident analysis computer code, the incremental risk of tritium production is not discernable from the risk of operation without tritium production. *Exposed population*: Due to accuracy limitations in the accident analysis computer code, the incremental risk of tritium production is not discernable from the risk of operation without tritium production. *Noninvolved worker:* Not applicable. Noninvolved worker has evacuated the plant before a release. Evacuation warning to noninvolved worker is at least one hour before a release. *Involved worker:* Most of the postulated accident sequences have adequate time for workers to evacuate the containment before there is a radioactive release to the containment. If the accident sequence is initiated by a large break loss-of-coolant accident or another high energy release mechanism, workers in containment will die due to the energy (steam) released to the containment. Evacuation from containment is not considered feasible during a high energy steam release accident scenario.	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual :* Due to accuracy limitations in the accident analysis computer code, the incremental risk of tritium production is not discernable from the risk of operation without tritium production. *Average individual in population:* Due to accuracy limitations in the accident analysis computer code, the incremental risk of tritium production is not discernable from the risk of operation without tritium production. *Exposed population*: Due to accuracy limitations in the accident analysis computer code, the incremental risk of tritium production is not discernable from the risk of operation without tritium production. *Noninvolved worker:* Not applicable. Noninvolved worker has evacuated the plant before a release. Evacuation warning to noninvolved worker is at least one hour before a release. *Involved worker:* Most of the postulated accident sequences have adequate time for workers to evacuate the containment before there is a radioactive release to the containment. If the accident sequence is initiated by a large break loss-of-coolant accident or another high energy release mechanism, workers in containment will die due to the energy (steam) released to the containment. Evacuation from containment is not considered feasible during a high energy steam release accident scenario.	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual:* 3.3×10^{-8} (1 fatality in 30 million years). *Average individual in population:* $1.4\text{x}10^{-10}$ (1 fatality in 7.1 billion years). *Exposed population*: 0.00017 (1 fatality in 5.8 thousand years). *Noninvolved worker:* Not applicable. Noninvolved worker has evacuated the plant before a release. Evacuation warning to noninvolved worker is at least one hour before a release. *Involved worker:* Most of the postulated accident sequences have adequate time for workers to evacuate the containment before there is a radioactive release to the containment. If the accident sequence is initiated by a large break loss-of-coolant accident or another high energy release mechanism, workers in containment will die due to the energy (steam) released to the containment. Evacuation from containment is not considered feasible during a high energy steam release accident scenario.

Resource/Material Categories	*Watts Bar 1*	*Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 2*
	For 3,400 TPBARs: *Maximally Exposed Individual:* 1.0×10^{-10} (1 fatality in 10 billion years). *Average individual in population:* 1.0×10^{-11} (1 fatality in 100 billion years). *Exposed population*: 0.000011 (1 fatality in 88 thousand years). *Noninvolved worker:* Same as for 1,000 TPBARs. *Involved worker:* Same as for 1,000 TPBARs.	For 3,400 TPBARs: *Maximally Exposed Individual :* 1.0×10^{-10} (1 fatality in 10 billion years). *Average individual in population:* 1.1×10^{-10} (1 fatality in 9.1 billion years). *Exposed population*: 0.00014 (1 fatality in 7.1 thousand years). *Noninvolved worker*: Same as for 1,000 TPBARs. *Involved worker:* Same as for 1,000 TPBARs.	For 3,400 TPBARs: *Maximally Exposed Individual:* 3.3×10^{-8} (1 fatality in 30 million years). *Average individual in population:* 1.5×10^{-10} (1 fatality in 6.6 billion years). *Exposed population*: 0.00018 (1 fatality in 5.5 thousand years). *Noninvolved worker:* Same as for 1,000 TPBARs. *Involved worker:* Same as for 1,000 TPBARs.
Waste Management	*Construction:* Potential non-hazardous waste if an ISFSI is constructed. *Operation:* Low-level radioactive waste increase by approximately 0.43 cubic meters per year. Other waste types would be unaffected by tritium production.	*Construction:* Potential non-hazardous waste if an ISFSI is constructed. *Operation:* Low-level radioactive waste increase by approximately 0.43 cubic meters per unit per year. Other waste types would be unaffected by tritium production.	*Construction:* Minor amounts of non-hazardous construction material waste generated during the completion of the plant. Potential non-hazardous waste if an ISFSI is constructed. *Operation:* Low-level radioactive waste increase by approximately 41 cubic meters per unit per year, of which 40 cubic meters would be from normal operations without tritium production.
Spent Nuclear Fuel Management	*Operation:* No increase if less than 2,000 TPBARs are irradiated. If 3,400 TPBARs are irradiated, the amount of spent fuel generated would increase by a maximum of 56 fuel assemblies per fuel cycle.	*Operation:* No increase if less than 2,000 TPBARs are irradiated. If 3,400 TPBARs are irradiated, the amount of spent fuel generated would increase by a maximum of 60 fuel assemblies per fuel cycle.	*Operation:* The amount of spent fuel would increase from 0 to approximately 72 spent fuel assemblies for less than 2,000 TPBARs. For 3,400 TPBARs, the amount of spent fuel generation could increase from 0 to a maximum of 141 spent fuel assemblies per fuel cycle, of which 72 would be from normal operation without tritium production.
Transportation	The risk associated with radiological materials transportation would be less than one fatality per 100,000 years.	The risk associated with radiological materials transportation would be less than one fatality per 100,000 years.	The risk associated with radiological materials transportation would be less than one fatality per 100,000 years. Traffic volumes on local roads could increase during construction and operations.

Resource/Material Categories	*Watts Bar 1*	*Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 2*
Fuel Fabrication	Not applicable for the reactor site.	Not applicable for the reactor site.	Not applicable for the reactor site.
Decontamination and Decommissioning	Decontamination and decommissioning would be required but not because of tritium production.	Decontamination and decommissioning would be required but not because of tritium production.	Decontamination and decommissioning would be required. For a generic discussion on impacts from decontamination and decommissioning, see Section 5.2.5.
License Renewal	Licensing renewal would be required. For a generic discussion on impacts from licensing renewal, see Section 5.2.4.	Licensing renewal would be required. For a generic discussion on impacts from licensing renewal, see Section 5.2.4.	Licensing renewal would not be required.

MEI = Maximally Exposed Offsite Individual
ISFSI = Independent Spent Fuel Storage Installation

Table S-3 Summary Comparison of Environmental Impacts Between CLWR Reactor Alternatives and the APT

Resource/Material Categories	*Watts Bar 1 or Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 1 and Bellefonte 2*	*CLWR No Action (APT at the Savannah River Site)*[a]
Land Resources			
Land Use	*Construction:* Potential land requirement—5.3 acres (Watts Bar) or 5.47 acres (Sequoyah) of previously disturbed industrial land for a dry cask ISFSI if constructed. *Operation:* Potential permanent land requirement - 3.1 to 3.2 acres, respectively, of previously disturbed industrial land for an ISFSI if constructed.	*Construction:* Potential land requirement—4.9 acres of previously disturbed industrial land for an ISFSI, if constructed, and additional small amounts of land for support buildings. *Operation:* Potential permanent land requirement - 3.4 acres of previously disturbed industrial land for an ISFSI, if constructed, and additional small amounts of land for support buildings.	*Construction and Operation:* 250 acres of land converted to industrial use. Additional lands for new roads, bridge upgrades, rail lines, and construction landfill. Additional 12 acres required for modular design, if selected. Additional land required for electric power generating facility, if constructed (e.g., 110 acres for a natural gas-fired facility and 290 acres for a coal-fired facility).
Visual Resources	*Construction and Operation:* No additional impact to visual resources.	*Construction:* No additional impact to visual resources. *Operation:* Vapor plumes under certain meteorological conditions would be visible up to 10 miles away.	*Construction:* No additional impact to visual resources. *Operation:* Vapor plumes under certain meteorological conditions would be visible.
Noise	*Construction:* No change from current levels. Small impacts if an ISFSI is constructed. *Operation:* No change from current levels.	*Construction:* No change from current levels except for construction vehicle traffic. Small impacts if an ISFSI is constructed. *Operation:* Increase in noise emissions from the plant from 50 dBA to 51 dBA at nearest receptor. Increase in traffic noise on site access roads from 50 dBA to 57 dBA due to commuter traffic and truck deliveries.	*Construction:* No change from current levels except for construction vehicle traffic. *Operation:* Increase in noise emissions from the new APT facility, electric power generating facility (if constructed), and support facilities.
Air Quality			
Non-radiological Emissions	*Construction:* No change from current air quality conditions. Small impacts if an ISFSI is constructed. *Operation:* No change from current air quality conditions.	*Construction:* Potential temporary dust emissions during construction. Small impacts if an ISFSI is constructed. *Operation:* The increase in nonradioactive emissions would be within established standards.	*Construction:* Potential temporary dust emissions during construction. *Operation:* The increase in nonradiological emissions would be within standards. Large increase in carbon dioxide emissions from any electric power generating facility.

Resource/Material Categories	*Watts Bar 1 or Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 1 and Bellefonte 2*	*CLWR No Action (APT at the Savannah River Site)*[a]
Radioactive Emissions	*Construction:* No radiological emissions. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 100 Curies; given 3,400 TPBARs, 340 Curies.	*Construction:* No radiological emissions. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 106 Curies; given 3,400 TPBARs, 346 Curies, of which 5.6 Curies would be from normal operation without tritium production. The release of other radioactive emissions would be 283 Curies.	*Construction:* No radiological emissions. *Operation:* The maximum potential increase in annual radioactive emissions of tritium would be 30,000 Curies in oxide form and 8,600 Curies in elemental form. The release of other radioactive emissions would be 2,250 Curies. Potential for an additional 2,000 Curies from electric power generating facility if power is acquired through market transaction (APT Final EIS p. C-46 & Draft EIS p. 4-80).
Water Resources Surface Water	*Construction:* No change to current surface water requirements, discharge, or water quality conditions. Small impacts if an ISFSI is constructed. *Operation:* No change to current surface water requirements, discharge, or water quality conditions.	*Construction:* Potential for increased storm water runoff. Small amount of surface water requirements. Small impacts if an ISFSI is constructed. *Operation:* Increased surface water requirements and discharge. Water usage less than 1 percent of Tennessee River flow per year. All water quality parameters within established limits.	*Construction:* Increased storm water runoff and impacts from dewatering. Surface water requirements. *Operation:* Increased surface water requirements and discharge. Potential for additional water requirements from an electric power generating facility, if constructed—4.7 billion gallons per day (coal-fired) and 1.4 billion gallons per day (natural gas-fired). All water quality parameters within established limits (APT Draft EIS p. 4-81).
Water Resources Radioactive Effluent	*Construction:* No radiological effluent. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 900 Curies; given 3,400 TPBARs, 3,060 Curies.	*Construction:* No radiological effluent. *Operation:* Given 1,000 TPBARs, the maximum potential increase in annual radioactive emissions of tritium would be 1,539 Curies; given 3,400 TPBARs 3,699 Curies, of which 639 Curies from normal operation without tritium production. The release of other radioactive effluents would be 1.32 Curies.	*Construction:* No radiological effluent. *Operation:* The maximum potential increase in annual radioactive tritium effluents would be 3,000 Curies and 0.0031 Curies from other radioactive emissions. Potential for an additional 19,000 Curies from the electric power generating facility if power is acquired through market transaction (APT Final EIS p. C-43 & Draft EIS 4-80).
Groundwater	*Construction and Operation:* No groundwater requirements or additional impacts to groundwater quality conditions.	*Construction:* Groundwater would not be used during construction. *Operation:* No groundwater requirements or additional impacts to groundwater quality conditions.	*Construction:* Due to below-ground construction of the APT, groundwater would be withdrawn and discharged to surface water. *Operation:* Potential for a 6,000 gallons per minute withdrawal of groundwater for APT cooling water (APT Draft EIS p. 4-3).

Resource/Material Categories	***Watts Bar 1 or Sequoyah 1 or Sequoyah 2***	***Bellefonte 1 or Bellefonte 1 and Bellefonte 2***	***CLWR No Action (APT at the Savannah River Site)[a]***
Ecological Resources	*Construction:* No additional impacts on ecological resources. Small impacts if an ISFSI is constructed. *Operation:* Small or no impacts to ecological resources from tritium production.	*Construction:* Potential impacts to ecological resources due to the small amount of land disturbance. Small impacts if an ISFSI is constructed. *Operation:* Impacts on ecological resources, including fish impingement and entrainment of aquatic biota during normal plant operation. Small impacts to ecological resources from tritium and other radioactive releases during normal plant operations.	*Construction:* Potential impacts to ecological resources due to land disturbance. *Operation:* Impacts on ecological resources, including fish impingement and entrainment of aquatic biota during normal plant operation. Small impacts to ecological resources from tritium and other radioactive releases during normal operations. Potential additional impacts on ecological resources from electric power generating plant, if constructed.
Socioeconomics	*Construction:* No measurable impact. *Operation:* less than 1 percent impact on regional economy.	*Construction:* 4,500 peak new direct jobs due to plant completion. Short-term increased costs and traffic for local jurisdictions. *Operation:* 800 to 1,000 workers per day. Increase in payment-in-lieu of taxes to state and local jurisdictions (approximately $5.5 to $8 million annually), decrease in the unemployment rate (from 8.2 percent in 1997 to approximately 6.2 percent), and minor impacts to school resources.	*Construction:* 1,400 peak new direct jobs. Short-term increased costs and traffic for local jurisdictions. Additional 1,100 peak jobs associated with new electric power generating facility, if constructed (APT Draft EIS p. 4-80). *Operation:* 500 workers per day. Increase in payment-in-lieu of taxes to state and local jurisdictions, decrease in the unemployment rate, and minor impacts to school resources. Additional 200 jobs associated with new electric power generating facility, if constructed (APT Draft EIS p. 4-80).

Resource/Material Categories	*Watts Bar 1 or Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 1 and Bellefonte 2*	*CLWR No Action (APT at the Savannah River Site)*[a]
Public and Occupational Health and Safety Normal Operation	Annual dose for 1,000 TPBARs: *Workers*: Total dose - 112.35 person-rem (Watts Bar) and 132.35 person-rem (Sequoyah). *Maximally Exposed Individual*: Dose increase by 0.013 millirem (Watts Bar) and 0.017 millirem (Sequoyah). *50-mile population*: Dose increase by 0.34 person-rem (Watts Bar) and 0.60 person-rem (Sequoyah).	Annual dose for 1,000 TPBARs: *Workers*: Total dose—112.35 person-rem per unit; 112 person-rem per unit from normal operations without tritium production. *Maximally Exposed Individual*: Dose increase by 0.263 millirem per unit, of which 0.26 millirem per unit would be from normal operation without tritium production. *50-mile population*: Dose increase by 1.6 person-rem per unit, of which 1.4 person-rem per unit would be from normal operation without tritium production.	Annual dose *Workers*: Total dose - 72 person-rem (APT Draft EIS p. 4-39). *Maximally Exposed Individual*: Dose increase by 0.053 millirem (APT Final EIS p. C-52). *50-mile population*: Dose increase by 3.1 person-rem (APT Final EIS p. C-52).
	Annual dose for 3,400 TPBARs: *Workers*: Total dose 113.2 person-rem (Watts Bar) and 133.2 person-rem (Sequoyah). *Maximally Exposed Individual*: Dose increase by 0.05 millirem (Watts Bar) and 0.057 millirem (Sequoyah). *50-mile population*: Dose increase by 1.2 person-rem (Watts Bar) and 1.9 person-rem (Sequoyah).	Annual dose for 3,400 TPBARs: *Workers*: Total dose—113.2 person-rem; 112 person-rem from per unit normal operations without tritium production. *Maximally Exposed Individual*: Dose increase by 0.28 millirem per unit, of which 0.26 millirem per unit would be from normal operation without tritium production. *50-mile population*: Dose increase by 2.3 person-rem per unit, of which 1.4 person-rem per unit would be from normal operation without tritium production.	

Resource/Material Categories	*Watts Bar 1 or Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 1 and Bellefonte 2*	*CLWR No Action (APT at the Savannah River Site)*[a]
Design-Basis Accident Risks	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual:* 3.4×10^{-8} (1 fatality in 29 million years - Watts Bar) and 7.9×10^{-9} (1 fatality in 130 million years - Sequoyah). *Average individual in population:* 4.0×10^{-10} (1 fatality in 2.5 billion years - Watts Bar) and 6.1×10^{-10} (1 fatality in 1.6 billion years - Sequoyah). *Exposed population:* 0.000074 (1 fatality in 13 thousand years - Watts Bar) and 0.00015 (1 fatality in 6.6 thousand years). *Noninvolved worker:* 4.2×10^{-10} (1 fatality in 2.4 billion years - Watts Bar) and 1.3×10^{-10} (1 fatality in 7.7 billion years - Sequoyah). For 3,400 TPBARs: *Maximally Exposed Individual:* 1.1×10^{-7} (1 fatality in 9.1 million years - Watts Bar) and 2.7×10^{-8} (1 fatality in 37 million years - Sequoyah). *Average individual in population:* 1.4×10^{-9} (1 fatality in 710 million years - Watts Bar) and 2.1×10^{-9} (1 fatality in 480 million years - Sequoyah). *Exposed population:* 0.00026 (1 fatality in 3.8 thousand years - Watts Bar) and 0.00052 (1 fatality in 1.9 thousand years). *Noninvolved worker:* 1.5×10^{-9} (1 fatality in 670 million years - Watts Bar) and 4.5×10^{-10} (1 fatality in 2.2 billion years - Sequoyah).	Increased likelihood of a cancer fatality per year due to tritium production. For 1,000 TPBARs: *Maximally Exposed Individual:* 3.5×10^{-7} (1 fatality in 2.9 million years). *Average individual in population:* 2.6×10^{-10} (1 fatality in 3.8 billion years). *Exposed population:* 0.000070 (1 fatality in 14 thousand years). *Noninvolved worker:* 1.2×10^{-12} (1 fatality in 830 billion years). For 3,400 TPBARs: *Maximally Exposed Individual:* 3.6×10^{-7} (1 fatality in 2.8 million years). *Average individual in population:* 8.0×10^{-10} (1 fatality in 1.3 billion years). *Exposed population:* 0.00022 (1 fatality in 4.6 thousand years). *Noninvolved worker:* 4.3×10^{-12} (1 fatality in 230 billion years).	Increased likelihood of a cancer fatality per year due to tritium production. Design-basis seismic event: 2.6 fatalities every 2,000 years.

Resource/Material Categories	*Watts Bar 1 or Sequoyah 1 or Sequoyah 2*	*Bellefonte 1 or Bellefonte 1 and Bellefonte 2*	*CLWR No Action (APT at the Savannah River Site)*[a]
Waste Management	*Construction:* Potential nonhazardous waste if an ISFSI is constructed. *Operation*: Low-level radioactive waste increase by approximately 0.43 cubic meters per unit per year. Other waste types would be unaffected by tritium production.	*Construction:* Minor amounts of nonhazardous construction material waste generated during the completion of the plant. Potential for additional nonhazardous waste material generated if an ISFSI is constructed. *Operation*: Low-level radioactive waste increase by approximately 41 cubic meters per unit per year, of which 40 cubic meters would be from normal operation without tritium production. Other waste types would also be generated due to tritium production.	*Construction:* 30,000 cubic meters of construction material generated and deposited in onsite landfill. Potential for additional nonhazardous waste material generated if new electric power generating facility is constructed. *Operation:* Low-level radioactive waste increase by approximately 1,400 cubic meters per year. Potential for additional 10,000 units of nuclear solid waste if power is acquired through market transaction (APT Draft EIS p. 4-80). Other waste types would also be generated due to tritium production and electric power generation (APT Draft EIS p. 4-26).
Spent Nuclear Fuel Management	*Operation:* No increase if less than 2,000 TPBARs are radiated. If 3,400 TPBARs are irradiated, the amount of spent fuel generated would increase by a maximum of 60 (Sequoyah), and 56 (Watts Bar) fuel assemblies per fuel cycle.	*Operation:* The amount of spent fuel would increase from 0 to approximately 72 spent fuel assemblies for less than 2,000 TPBARs. For 3,400 TPBARs, the amount of spent fuel generation could increase from zero to a maximum of 141 spent fuel assemblies per fuel cycle, of which 72 would be from normal operation without tritium production.	*Operation:* Spent nuclear fuel would be generated under the market transaction/existing capacity alternative for electric power generation.
Transportation	The risk associated with radiological materials transportation would be less than one fatality per 100,000 years.	The risk associated with radiological materials transportation would be less than one fatality per 100,000 years. Traffic volumes on local roads could increase during construction and operations.	Transportation within the Savannah River Site only.
Fuel Fabrication	Not applicable for reactor site.	Not applicable for reactor site.	Not applicable for APT facility. Yes for electric-generating facility.
Decontamination and Decommissioning	Decontamination and decommissioning would be required but not because of tritium production.	Decontamination and decommissioning would be required. For a generic discussion on impacts from decontamination and decommissioning, see Section 5.2.5.	Decontamination and decommissioning would be required.
License Renewal	Licensing renewal would be required. For a generic discussion on impacts from licensing renewal, see Section 5.2.4.	Licensing renewal would not be required.	Licensing renewal is not applicable.

[a] Based on tritium production of 3 kilograms of tritium per year.

AVAILABILITY OF THE CLWR Final EIS

Copies of the CLWR Final EIS may be obtained by calling DOE's Office of Defense Programs at 1-800-332-0801.

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